ICE-BOATING

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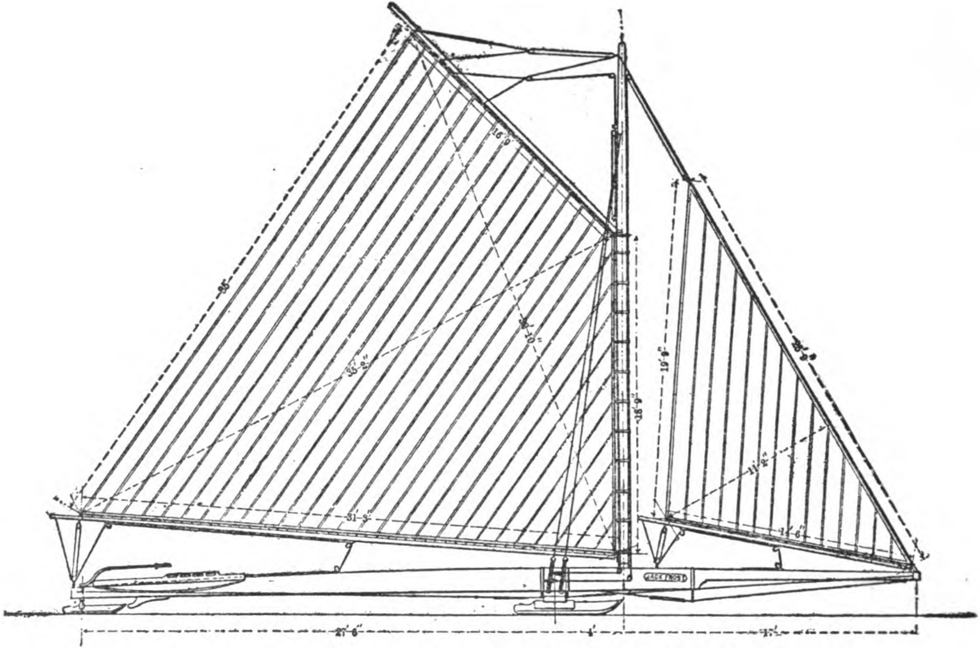

Ice-yacht *Jack Frost:* the holder of the Ice-Yacht Challenge Penant of America.

ICE-BOATING

The Latest Opinions of the Foremost Authorities in America

Edited by

HERBERT L. STONE

EDITOR OF "YACHTING"

Illustrated with Diagrams

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CHAPTER I

The History and Development Of Ice-Boat in America

ALTHOUGH ice-boating, or ice-yachting as it is sometimes called, has been an organized sport in this country for nearly half a century, but little comprehensive information in regard to it is obtainable, no data have been kept of the evolution of the boats, and there are no records of what has been accomplished in various parts of the country where the sport flourishes. There is no literature on the subject outside of a few disconnected articles on ice-boats that have appeared from time to time in magazines devoted to boating and outdoor sports. The natural result of this is that, though ice-boating has flourished in widely separated parts of the country, no uniform rules yet govern the sport, and local usage and traditions have frequently prevented the best development of the boats. An-

other thing that has kept the evolution of the ice-yacht from keeping pace with that of other craft is that as yet there has been no commercial incentive for its perfection, a very potent factor in bringing the sailing yacht to its present high state of development.

While, naturally, ice-boating is limited, geographically, in the United States to the northern portions of the country where ice can be reasonably counted on for three months of the year, there are wide possibilities for its enjoyment from Maine to the Rocky Mountains, north of the fortieth parallel. Any river or lake where a straight stretch of a mile or more can be had, will, if fairly free from snow, make an excellent course for an ice-boat. At present the principal and best known ice-boating centers where the sport is organized, are the Hudson River, Orange Lake and Lake Chautauqua in New York, the Shrewsbury River in New Jersey, Lake Champlain, Gull Lake at Kalamazoo, Mich.; the Wisconsin and Minnesota Lakes and along the American shores of the Great Lakes; while Lakes Seneca and Cayuga in New York, and the fresh waters around Boston see more or less boating, though in rather a desultory way.

Considerable rivalry exists between these different sections and this, together with lack of information as to what has been accomplished elsewhere, has resulted in the development of different types of boats in different localities, the difference being principally in the rig, step and rake of the mast, position of the runner plank, etc. There is, for instance, the distinctive Hudson River type, now generally adopted in the East; the Madison type which originated on the lakes around Madison, Wis.; and a type that was developed in northern Michigan, though here the influence of the sections mentioned above is now being felt.

The greatest advance in ice-yacht design has been made in the East, within the last twenty-five years, and in particular along the shores of the Hudson River, while the development of scientifically designed ice-yachts and the better dissemination of information as to what is being done by the leaders in the sport is rapidly bringing these varying types closer together.

It is hard to say just when the first ice-boat was built. Probably a small boy with his coat spread out before the wind furnished the idea. Those who have followed the development of

ice-boats most closely claim that they were first used about one hundred years ago. However that may be, the Shrewsbury River ice-boatmen some five years ago celebrated the seventy-fifth anniversary of the sport in New Jersey. In the 50's of the last century resourceful Jerseymen are said to have mounted square boxes on four runners, rigged up a sail and gone sailing over the ice whenever there was wind, steering with a pike pole. Later it was found that one runner could be dispensed with and the third, or after runner, was used as a rudder to steer the boat. To add to the stability and decrease the weight, these crude affairs were eventually spread out to give a greater span or base to the runners, and were reduced to a mere skeleton of keel or backbone and a cross runner plank with a small cockpit at the after end.

Along the Hudson River the sport thrived before the outbreak of the Civil War and it was here that the first ice-yacht club was said to have been formed in 1861 (the Poughkeepsie Ice-Yacht Club). Of the development of ice-boats along this water way, which may really be said to be the center of the sport in the East, Mr. Archibald Rogers, one of the fore-

most ice-yachtsmen of the country has this to say:

"The early yachts of the Hudson were constructed a good deal on the lumber-box order. They were heavy, hard-riding, and hard-headed, too, generally jib and mainsail in rig, the mast set up over the runner plank, and not some distance ahead, as prevails at present. They had short gaffs, long booms, moderate hoist, and big jibs. This stepping of the mast over the runner-plank gave the boats a bad balance—that is, it brought the center of effort too far aft, and also the weights; consequently the tendency in beating to windward was to luff, and this had to be avoided by keeping the boat's head off. The weight of the mast being too far aft also brought additional pressure on the rudder. All this unnecessary friction caused a proportionate loss in speed, especially to windward.

"This type of yacht reached its greatest development in the *Icicle,* the largest ice-yacht ever constructed. She was built in 1869, and was improved and enlarged until she measured 68 feet, 11 inches in length, with sail-driving area of 1070 square feet. She was unquestionably the fastest in 1879 of any of the yachts

on the river. It was not long, however, before an improved type of rig and construction made its appearance, and this was accomplished by stepping the mast about three and a half feet farther forward, or ahead of the runner-plank. This necessitated shortening the jib, making it more of a balance sail than before. Main booms, too, were cut off and gaffs lengthened, bringing the sail more inboard, thus placing the center of effort in more proper relation to the center of resistance. Side rails and cockpits gave way to wire guys with adjustable turn-buckles, and small, elliptical boxes for the helmsmen."

The coming of the first boat of this improved design marked the beginning of the application of scientific principles in ice-yacht design, and had as much influence on the future of these boats as the *Gloriana* did on yacht design when she came from the board of Herreshoff. This boat, the *Robert Scott*, was designed and built by H. Relyea, the Hudson River ice-boatman, in 1879, and she was very successful—winning many races and proving throughout that she was built and rigged on correct principles. She even defeated *Icicle* which had twice as much sail as the new boat, the latter carrying about

499 square feet. It was the influence of this boat that resulted in the building of *Jack Frost* a few years later, of the same type but of somewhat larger size. This *Jack Frost* is probably one of the best known and fastest ice-boats ever built and was several times the winner of the ice-yacht challenge pennant of America.

The limit of size was likewise reached in these boats, *Icicle* and *Jack Frost,* and since then the tendency has been toward a somewhat smaller boat. This was also due to the fact that as the sport became better organized ice-boats were divided into classes according to the size of their sail area, in order to bring about uniformity. These classes run from the 150 square foot class of the "mosquito" boats, up to the 600 square foot class, and while some few boats are still built with a larger area than the last named class, the bulk of the building is to regular classes and chiefly from the 250 to 450 square foot sizes. Different sections of the country have taken up particular classes; just as at Orange Lake the 250-foot class is the most popular, while at Kalamazoo the 450-square foot class has the call, and the prospective builder will do well to find out before starting his boat just what classes are used where he

intends to sail and into which particular one he wants to go.

ESSENTIAL POINTS IN ICE-BOAT CONSTRUCTION

In building an ice-boat there are several essential points in the design and construction that must be borne in mind if one wants a successful craft. The chief of these is lightness combined with great strength, for the strain and racking that the light frame receives is beyond what is usually estimated by the novice. This lightness is obtained by a careful selection of wood, by the use of trussed or composite back bones, hollow spars, light cockpits, etc. Great pains should be taken in the selection of the timber for a boat that is designed for speed, as most ice-yachts are. For the backbone or center timber and runner planks basswood and butternut are preferred, though the scarcity of these woods has brought spruce, ash, and sometimes fir, into quite general use in some localities.

Another essential feature is elasticity in the runner plank. In the past it was generally thought that rigidity and stiffness were required in all parts, but this has been rather generally

disproved, a certain amount of elasticity not only adding to the speed but to the comfort of the boat when riding over rough ice.

The quality and design of the runners is also a vital point in the successful boat and to get flexibility these runners are attached to either end of the runner plank between chocks or guides and are pivoted to allow a certain amount of vertical play, thus lessening the shock received from the inequalities or rough spots in the ice, the impact of which not only tends to stop the boat but makes extremely hard riding. As the iron shoes of the runners are vital parts of the boat a great deal depends on them. The generally accepted metal for this is soft cast iron, either colored or with a small proportion of some other metal mixed with it.

There is still some difference of opinion as to the relative advantages of straight and "rockered" runner shoes. Long bearing surfaces to runners give a better hold on the ice and prevent sliding to leeward, but they make the boat hard to turn and the excessive jarring of a straight runner over rough ice retards the speed so that at least a slight rocker in the runner is usually preferred. In explaining his preference for this latter type, Archibald Rogers

says, in a pamphlet on the "Development of the Ice-Yacht on the Hudson:"

"Take one of the large yachts; her weight would be at least 3,000 pounds, including everything. Move this body, say, at the rate of forty miles an hour, or 58.6 feet per second; a hard frozen hummock of snow or ice is encountered; now if the plank is rigidly trussed and the runners straight or without rocker, the blow must be a severe one, and the shock to the other parts of the yacht much more severe, entailing heavier construction in all its parts, hence increased friction and a loss in speed. While, on the other hand, with a properly proportioned, flexible runner-plank, and an easy, gradual rocker to the runners, the yacht so equipped will glide up the obstruction, and shooting ahead clear of the ice, drop down with very little perceptible jar, though the runner-plank may have been deflected as I have often witnessed, six or seven inches vertically from its normal arched position."

The proper balance of a boat is another important consideration and after years of experiment and observation this has been worked out in a satisfactory manner and the possibilities of the different rigs are now well known, the

center of effort of the sails falling slightly forward on the center of lateral resistance to get the best results.

Various rigs have been tried, chief among which are the jib and mainsail, the lateen, and the cat rig. Each of these rigs still has its advocates and has received a thorough test, but in the end the one which has prevailed and is in most common use is the jib and mainsail. Various modifications of the lateen rig have been tried, though that most commonly used has two sheer poles running upwards from the end of each runner plank and meeting in the center over the backbone beneath the apex of which the yard of the lateen sail is hung. While this sail has the advantage of having its area all in one piece, the rig naturally needs very long and heavy spars and the boats frequently prove hard to handle. In small boats the rig is still used very successfully on account of its simplicity. The cat rig has been adopted with fair success on boats of the smaller sizes where not more than 250 feet of sail was used, and while it has been tried on boats with as high as 800 square feet of canvas, it has not proved an unqualified success. The mast, naturally, has to be placed well forward in this rig to preserve

the balance of the boat. But while the cat rig has not been generally adopted, the sloop rig has been undergoing a gradual change which has resulted in the mainsail being made larger and larger and the jib smaller, so that at present the jib is a very small affair used more to obtain proper balance for the boat than for any driving power that it might have.

Sails are another important consideration, and a great deal of attention should be given to their cut and quality. They can be made at home if desired, especially in boats of the smaller or "mosquito" classes, but in larger boats and racing craft the job had better be given to a sail maker who has facilities for doing the work properly and well. Sails, nowadays, are mostly cross cut, as in sailing yachts, but are cut very flat, practically without draft, and this point should be impressed upon a sail maker if he is not already familiar with the making of sails for ice-yachts. The tendency is also toward high, narrow sails instead of the older low cut rigs. This gives a higher center of effort, and while they are apt to make the windward runner lift off the ice quicker than with the older sails, they drive a boat to windward better, and even the lifting of the boat is

easier than in the low cut rigs. Two, and sometimes three battens are used in the leach of the sail to keep it flat.

Wire standing rigging should be used entirely and in large yachts wire halyards should also be used as it has no stretch to it. Both should be of the very best material—either crucible steel wire or the best bronze wire rope. It has been found that windage plays an important part in the speed of a boat and in the modern yacht it has been reduced to a minimum by the use of such standing and running rigging as has just been mentioned, and by keeping the size of the mast and spars down as much as possible. The mast should extend only high enough above the mast head to properly support the peak halyards.

As regards the cost of building an ice-boat, the figures are, of course, very elastic, depending on the size of the boat, the quality of material and workmanship, and whether or not she is built by some well known builder, such as George Buckhout of Poughkeepsie. The material for a new boat of about 150 square feet can be purchased for from $50 up, and she can be easily put together by any one with a knowledge of handling tools; and if the plans of a

well designed boat are followed, she should make a very satisfactory little craft. A boat about 50 feet long with some 700 or 750 square feet of sail, completed in the best possible manner and of the best material by a builder (in which case the labor must be figured in) may go as high as $900 or $1,000. A good boat in the smaller classes can be built, including labor, from $200 to $500 depending on the size. Between this wide range in price a boat can probably be built to suit any pocket book, and in the description of some of the boats that follow the cost of material is given so that the prospective builder may know about what outlay would be necessary before beginning the work.

In the development of the ice-boat, the names of a number of men who have had the best interests of the game at heart stand out prominently, and it is to these that the development of the ice boat from the crude affair built by rule of thumb methods to the scientifically designed machine is due. A full list would include many names well known to those who have followed the sport, but a few of them may be mentioned here, such as; Archibald Rogers, the man who has given liberally of his

time and money for the development of the ice-boat; H. Relyea, George Buckhout, of Poughkeepsie; Commodore Henry H. Higginson on Orange Lake; H. Percy Ashley; D. C. Olin, of Kalamazoo; Emile Fauerbach, of Madison, Wis.; Dr. William M. Stanbrough, of Orange Lake; James O'Brien and others.

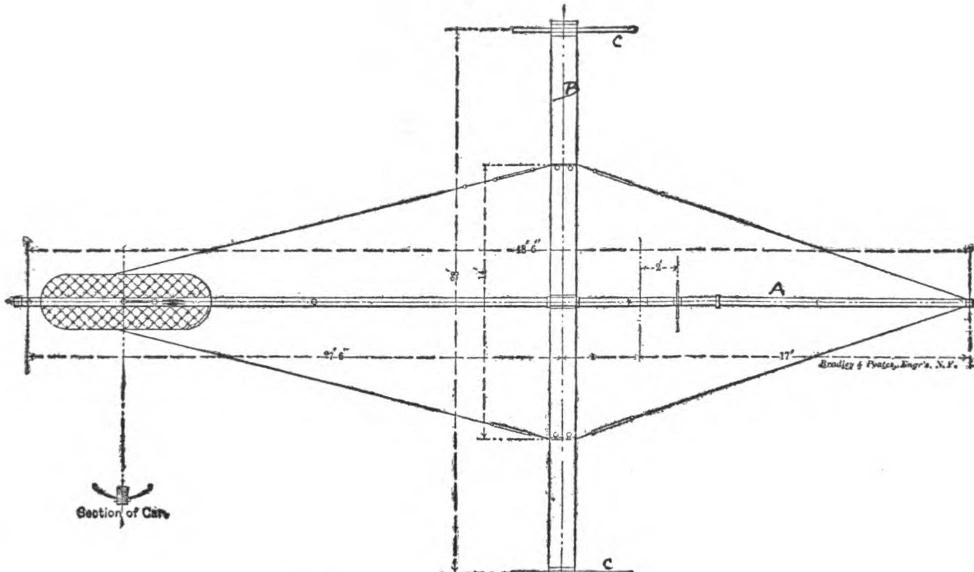
CHAPTER II

Building An Ice-Yacht

BY ARCHIBALD ROGERS

BY referring to the diagram, it will be noticed that there is little comparison between the hull of an ice-yacht and that of a boat built to sail on the water. There are three principal elements in the construction of an ice-yacht; the hull, or backbone, commonly called the center-timber (marked A in the diagram), the runner-plank on which it rests (B), and the two runners attached to each end of the runner-plank (C) and the rudder (D). The mast and the sails speak for themselves, and as can be seen are mounted directly on the center-timber a short distance forward of the runner-plank.

It will be noticed that the runner-plank is attached by a gammon iron to the center-timber, about midway between each end, and that the

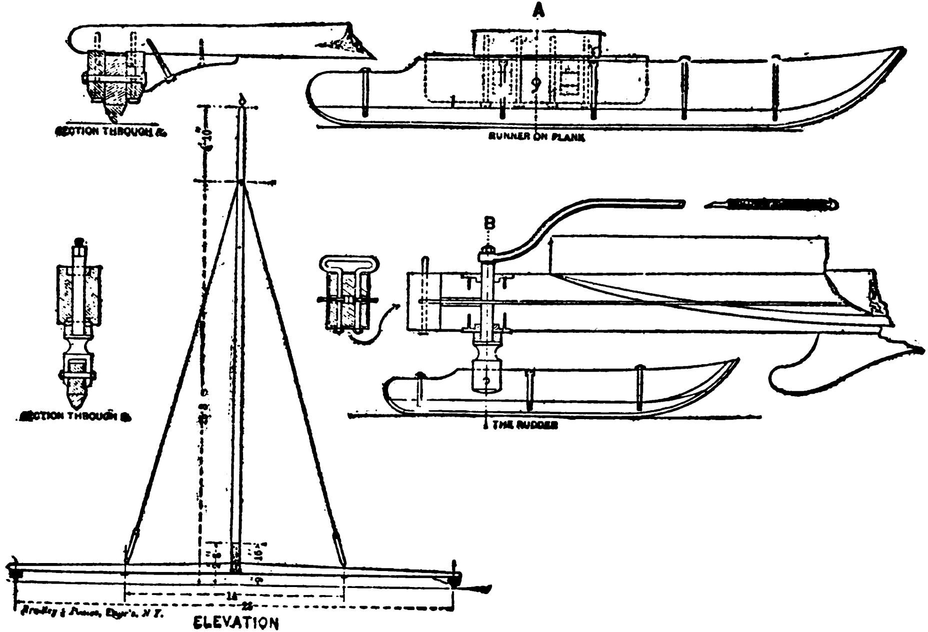


Plan of typical ice-yacht—*Jack Frost.*

rudder is attached to a rudder-post which passes through the center-timber at its after end. This rudder, in one sense, is the only movable portion of the yacht. It has a horizontal as well as a vertical movement. The runners are attached to chocks at each end of the runner-plank and are held there by through-bolts, which pass through the chocks, allowing the runners up and down vertical play and preventing at the same time any side motion. In other words, these two runners are kept absolutely firm in a fore and aft line and parallel to each other.

Many other methods have been tried in the past, but that which has just been described seems the best result of many years of experiment.

Much more care and attention are now paid to details than was the case formerly. The death of the late George Buckhout, of Poughkeepsie, was an irreparable loss to users of ice-boats, for he combined all the elements of a keen sportsman with the knowledge of a practical boat-builder. Thanks to him, every detail about a yacht is now carefully thought out, and only the very finest of material is used: the very best plow-steel rope for rigging, flexible



Elevation and details of runners and rudder of typical ice-yacht.

wire halyards and modern cross-cut sails, with, in many instances, hollow spars, marking the present advance in construction. Here and there, not only hollow spars are being used, but the backbone or center-timber is also being built hollow.

Various kinds of wood are used by the different clubs for both center-timbers and runner-planks; bass wood was the favorite in the past. Of course, for a small yacht any good, light, strong wood is suitable, but for a large one (yachts vary in length from 15 to 50 feet) it becomes a difficult problem to find sound trees large enough from which the necessary timbers can be sawed, most of the fine bass wood having been long ago cut up by the saw-mills. Butternut is an excellent wood for making both the runner-plank and center-timber, but this too, unfortunately, is exceedingly scarce. It can easily be imagined how difficult it is to find a tree, when the runner-plank for one of the large racing yachts requires a tree sound and clear of branches for 30 feet, and at least 34 inches in diameter inside the bark at the small end. Such trees are few and far between to-day in our forest.

Having secured such a tree, much care is re-

quired in cutting it down, so that no injury will ensue through the straining of its fibers. Nor is it an easy task to transport such a large piece of timber to the saw-mill. However, having arrived there, this log is usually slabbed on four sides, so that it may rest truly on the carriage; then a cut should be taken to eliminate the heart wood. This will leave two large pieces, and one of these is taken for a runner-plank. The part which is nearest the outside of the tree, or the sap wood, forms the underside of the plank. This, drying more quickly than the wood nearest the heart, tends to pull the two ends together, and thus a natural crown or bow is given to the plank, which is a most desirable feature. When thoroughly seasoned it is worked down to final dimensions and finished. The other piece of timber mentioned above is generally used to make a center-timber out of, and this is done by cutting it into two pieces and scarfing these together to make the desired length. We have now the runner-plank and the center-timber: the former a broad, flexible wooden spring, and the latter more or less a stout timber on edge, fastened by an iron gammon-strap to the center of the runner-plank.

In explaining why the runner-plank should

have an arch or crown to it, and why it should possess the elements of a spring, it is necessary to say that this seems to be the best result of many different methods of construction in this line. Some yachts used to be built with what is called a trussed or rigid runner-plank that could not bend at all, either from the weights resting on it or from the pressure coming down through the mast and shrouds.

Of course, if the runner-plank, carrying as it does a very large proportion of the weight of the boat, were made rigid it would ride very hard even if the ice were absolutely smooth. Such ice being seldom found and lasting for a very short period, it is desirable, therefore, to have a certain amount of elasticity. The weight concentrated on a springy plank will not cause such jars and strains to the rest of the boat, as is the case when a trussed or rigid plank is used. Striking the ice in a hard and inflexible way must necessarily militate against the speed of a boat.

Next, and a most important feature of the yacht, are the runners on which she glides over the ice. The metal part of the two runners and also the rudder are a good deal alike. They are V-shaped castings, attached to well-sea-

soned tops of oak by bolts, which go down through the wood and are tapped into the top of the castings.

The cutting surface, or part which rests directly on the ice, is first planed up at an angle of about 90 degrees (between the faces) with faces of from half an inch to one inch, and then carefully finished to an absolutely smooth surface. As mentioned before, two chocks, with the necessary opening to admit the wooden part of the runners, are securely fastened to each end of the runner-plank in a fore and aft line. The runners are then attached to these chocks by a horizontal through-bolt, thus permitting the runners to play up and down—a very important point in going over rough ice in connection with the flexibility of the runner-plank.

Another point also, and one in which there seems to be considerable variation in practice, is the proper length or surface of the metal part of the runners in contact with the ice. It seems to be the practice to give some rocker, but many boats are built with runners which have a very long bearing. It can be readily understood, of course, that this will have a strong tendency to prevent any sliding off to leeward, but on the other hand it makes it very difficult

to turn the yacht and those thus equipped grind much more in coming about than those fitted with runners of a considerable rocker.

As to material, the very best grade of cast iron seems to be the most used for runners and rudders. The friction at high speeds between the ice and the runners gives a smooth and very hard polish to that part of the metal in contact with the ice; so much so, that when it becomes necessary to sharpen a pair of cast-iron runners after their having been in use a few weeks, it will be found that it takes a great deal of filing to get through this polish and glaze. Other metals, of course, have been tried: cast steel, Norway iron, and in one instance phosphor-bronze. This latter, the writer knows from actual experience, proved very disappointing. It seemed to stick to the ice, and especially so if there was the least bit of snow on it. A high grade of tool steel is no doubt very good, but the difficulty in sharpening such runners leads to the belief that it would be hard to find any metal superior to the best cast iron.

The rudder is attached to a rudder-post, which has a fork at the lower end and a through-bolt which permits vertical motion for

the rudder. The rudder-post, passing through the stern end of the center-timber is fitted at its upper end with a long iron tiller. The hole in which the rudder-post plays in the center-timber should be fitted with glands, and it is well to have a rubber buffer around the rudder-post for the center-timber to rest on as this greatly lessens the jar on the rudder.

The writer deems that the only radical differences between the sails of an ice-yacht and those of a sailing-craft are the way in which they are cut, and the weight of the canvas. In the early ice-yachts sails were ridiculously heavy; some being constructed out of canvas that was as heavy as the mainsail of a full-rigged ship. But nowadays one sees canvas nearly as light as that used on the water.

A good practice is to use about two numbers heavier than that which would be selected for a racing-yacht on water. It must be borne in mind, of course, that we have a decided advantage at present in the great superiority of yacht-duck as furnished by the best sail-makers. There is in the cutting of the sails, however, a radical difference. The writer believes that it would be difficult to cut an ice-yacht sail too flat. In other words, no draft should be given

to either jib or mainsail. I think this is borne out by experience and fact as to the superiority of those boats having very flat sails over those to which draft has been given.

There is in the luff of the mainsails of all ice-yachts traveling at high speeds a certain back draft from the jib; this seems to be well-nigh inevitable, and is quite conceivable when we bear in mind that the sails are always trimmed flat aboard, and the leach of the jib being so close to the luff of the mainsail, the wind on leaving it strikes the luff of the mainsail on the leeward side, thus forcing it out to windward and making more or less of a bag at that point.

CHAPTER III

How to Build a 200-Square Footer

BY H. PERCY ASHLEY

IN working up these plans and specifications I have taken for granted that you are residing in a town situated on some lake or river that produces a good crop of sailing ice each winter; also that you have a fair knowledge of the use of ordinary carpenter's tools. Before you contemplate procuring your material see that every tool you possess is in good working order and sharp, and that you have access to the necessary implements to resharpen them. This is the first decisive step in building a boat. The plans and specifications that follow are for a boat of the two hundred foot class—simple to construct and handle, and capable of carrying four men or of being sailed as a single-hander.

It will be presumed that your town contains the ordinary lumber yard, blacksmith shop and hardware store. If it does not possess a fur-

nace where they cast soft iron there probably will be one not far away. In selecting your lumber get only that of the first quality as free from knots and checks as possible, and perfectly seasoned. This is very essential.

Use Swedish iron for all wrought iron work in preference to any other as it will stand a sudden strain much better. The runner shoes can be made of nothing but soft cast iron; ordinary cast iron will not do.

GENERAL STRUCTURAL FEATURES

The formation of the hull or body of an ice-yacht is not at all complicated. The center-timber or backbone extends the full length of the hull. To this is attached the cockpit or box occupied by the steersman and passengers. At right angles to the backbone is the plank to which are fastened the runners—known as the runner-plank. This plank and the backbone are fastened together with an iron band called a saddle. (See under *Ironwork.*)

Each fore runner fits between two parallel, elongated, oak blocks which are fastened to the runner-plank at right angles to it and on the under side a slight distance from the ends.

The inner one of each pair of these oak blocks or chocks is braced from the inside by two wooden brackets. The forward runners are secured to their chocks by means of a pivot-bolt, which allows the runner to rock in passing over rough ice.

At the extreme after end of the cockpit is placed the rudder-post with the tiller or steering bar with which to guide the boat. At the lower extremity of the rudder-post is a fork in which the rudder runner is installed. This runner also rocks on a bolt at right angles with the runner rudder, as do the fore runners.

To keep the runner-plank always at right angles with the backbone four guys of steel rigging are used. The two runner-plank forward guys extend from the extreme forward end of the backbone to the two points on the runner-plank on opposite sides from the backbone and equidistant from it. At each of these points there is placed a straight strip of iron, bored with suitable holes to receive the eye bolt for the shrouds or wire stays to support the mast. (See under *Ironwork*). At the ends of this *runner-plank guy strap* are attached the forward and aft runner-plank turnbuckles into which are spliced the forward and

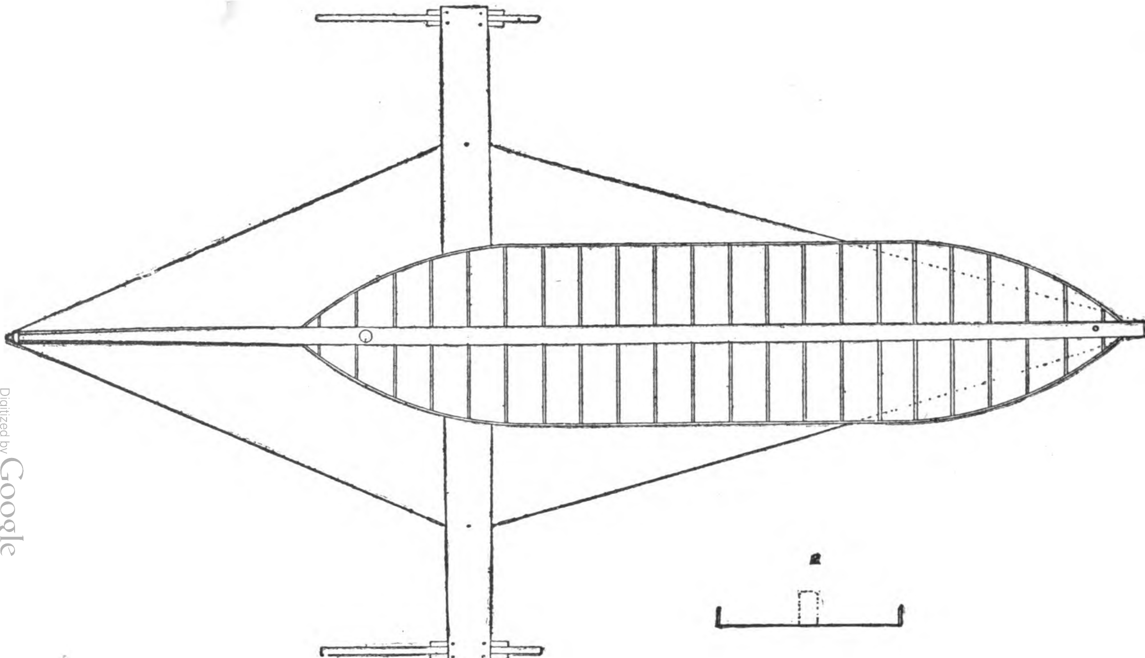


Plate II.—Backbone, runner-plank and plan of hull.

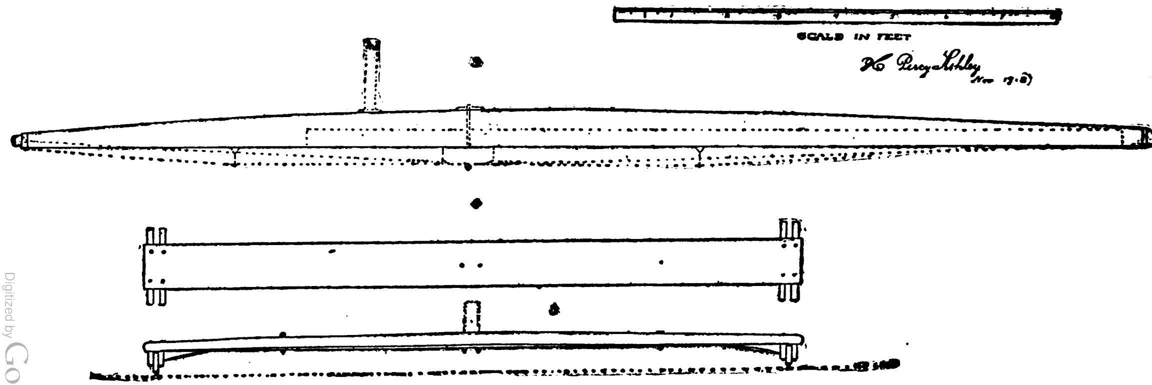


PLATE II-A.—Detail of backbone and runner-plank.

aft wire guys. These four guys extend respectively to the nose (forward end) and heel (after end) of the backbone, there ending in spliced loops which are inserted, two over the nose and two over the heel. The ends of the backbone have previously been brought down to a shoulder to receive them.

The bobstay is a piece of wire rigging, the forward end spliced into itself to form a loop, which is also slipped over the shoulder at the nose. It extends under the backbone and passes under the runner-plank to a point just forward of the forward end of the steering runner on the under side of the cockpit. Here the bobstay is secured to a strip of iron called the bobstay iron, fasted to the hull of the ice-yacht by lag-screws. To this iron is attached a turnbuckle, and the after end of the bobstay is spliced around a thimble on the latter. At designated points on the under side of the backbone are located two struts or spreaders. With the wire bobstay passing under these and made taut by means of the turnbuckle there is formed a truss which reinforces the strength of the backbone. Plate II. gives you a general idea of the hull. In the upper of the two drawings the runner-plank guys are shown in their posi-

tion with turnbuckles attached, while the formation of the bobstay is shown in the lower drawing.

On another part of the plate you will find a scale. By retracing this scale on transparent paper and placing the paper over any part of the drawing the correct measurement of that part can be obtained.

RIG

The sloop rig is found to be the most satisfactory and practical for an ice-yacht. This rig is composed of two sails, the forward one —called the jib—being set upon the forestay and the after one—called the mainsail—set upon an upper and a lower yard, called the gaff and boom, respectively, and having the luff, or forward side, held close to the mast by means of a lacing or by mast hoops.

The mast itself is stepped upon a plate having an upward extension which fits into a groove in the heel of the mast. This plate is fastened upon the upper side of the backbone forward of the runner-plank. On the after side of the mast at a suitable distance above the backbone is attached an iron fitting called a

gooseneck, the purpose of which is to act as a hinge for the main boom and enable it to swing off on either side of the fore and aft center line of the hull.

The mast is supported in an upright position by three wire stays. The one on the right hand side is called the starboard shroud and that on the left hand the port shroud, while the forward one is known as the jib stay. The two shrouds are of wire rope and have a spliced loop passed over the upper end of the mast; the lower end of each passes through the eye of a turnbuckle equipped with a wire thimble and fastened into an eyebolt in the runner-plank. The jib stay is secured at the masthead by a loop which is slipped over the masthead. The loop in the lower end is connected by means of a shackle with a U-iron at the nose of the backbone. The purpose of this fastening is to allow the jib stay to be easily disconnected when the ice-boat is dismantled for the summer.

Passing on to the running rigging, the mainsail is raised and lowered by means of two ropes called the throat and peak halyards. The gaff is fitted with a bridle; that is, a piece of pliable wire rope having an eye spliced in each end and slipped over the gaff, one loop

of the bridle remaining at the center of the gaff, and the other one fastened around the outer extremity of the spar. To this bridle is attached the peak halyard bridle block. (See Plate VI., No. Ten.) One end of the peak halyard is spliced into the becket of a single-sheave brass block at the masthead, whence it leads through the bridle block just mentioned, thence back to the masthead block and through that down to the deck.

The end of the gaff next to the mast is fitted with a crotch of two pieces of oak—known as the gaff jaws. These straddle the mast and allow the gaff to swing as required without its inboard end becoming disengaged from the mast. The inner end of the gaff is hoisted by means of the throat halyard, which is a rope passing through another bronze block on the after side of the mast, below the peak halyard block and secured to the gaff over the throat. For additional purchase a second block is usually employed at the jaws, the halyard passing through it and back to a becket in the throat halyard block; (Plate VI., No. 10); or double sheave blocks may be employed, in which case the mechanical advantages of the purchase will be doubled.

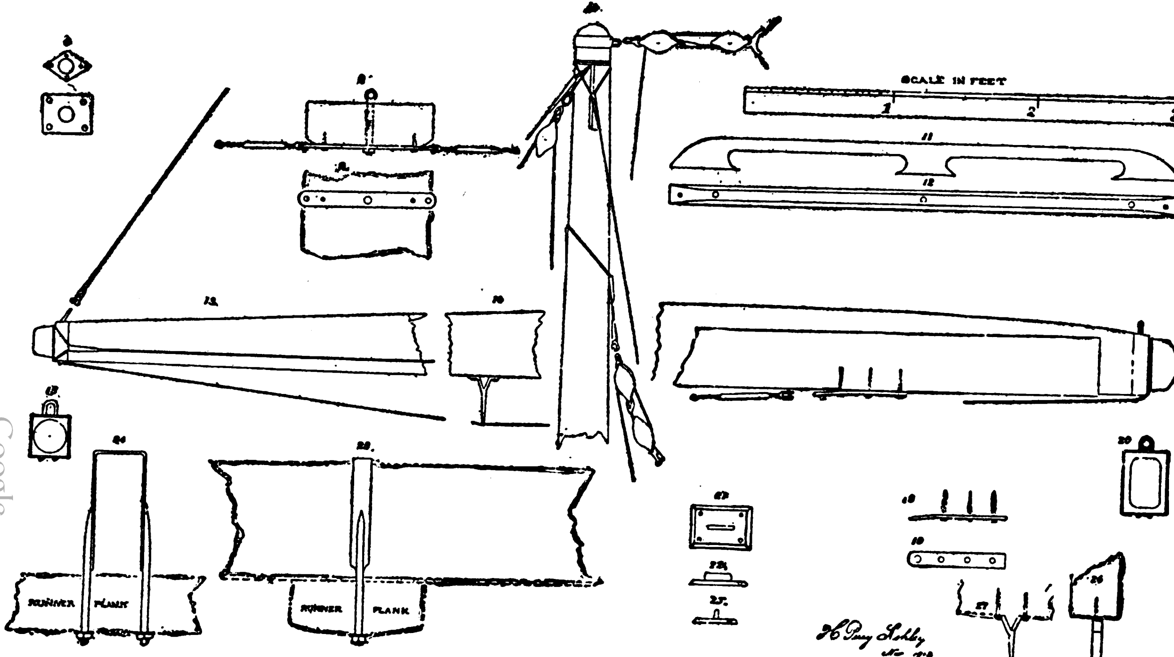


PLATE VI.—Details of construction and rig.

The rope which raises the jib is known as the jib halyard while the one which holds it in place at its lower inner corner is the jib sheet. The main sheet is the rope connecting the main boom with the after end of the backbone and used to trim the mainsail as required. The throat halyard block is suspended by a loop of pliable wire termed the throat becket. This becket passes around the mast and is prevented from slipping down the mast by a shoulder cleat which is simply a piece of straight grained oak five inches long and one inch wide and five-eighth of an inch thick, the lower end being sunk one-eighth inch deep in the mast.

There are also two of these cleats placed at the masthead, three inches below its upper end, for the loops of the two shrouds and the jib stay to rest upon. (Plate VI., No. 10.) They are made wedge shape on the contact side only. The ones at the masthead are situated on right and left sides of the mast. There are also small cleats on the lower side of the gaff to hold the ends of the bridle in their proper position.

BACKBONE OR CENTER-TIMBER

Dimensions: Length over all, 21 feet;

width, 3¾ inches; depth at nose, 3¾ inches; at center, 8½ inches; at heel, 5½ inches. The backbone is tapered from mast to nose and the upper edges are rounded. The lower side is perfectly straight for the full length. (See Plate II., No. 3).

The formation of the nose and heel is shown on Plate VI., Nos. 13 and 16. Only straight grained wood may be used and it should be as free from knots as possible with the heart on the upper side. Material: Basswood, or butternut, or, if these cannot be obtained, ash, spruce, Washington fir or well seasoned pine.

RUNNER-PLANK

In this case also the heart of the wood should be on the upper side to increase the resiliency of the plank which is essential in passing over rough ice. Dimensions: Length, 12 feet, 2 inches; thickness 3½ inches at center, 2½ inches at ends; width, 11½ inches at center; 10½ inches at ends.

Trim down the upper side of plank as shown on Plate II., No. 5. Start from nothing at the runner chocks and gradually round the front and rear lower edges. (Plate II., No. 5 and

Plate VI., No. 25). On Plate VI., No 25, is shown where holes are to be bored for runner chocks, shrouds, eyebolts, and a saddle which holds the backbone and runner-plank together.

COCKPIT OR STEERING BOX

Length over all 15 feet; width 3 feet 4 inches; flooring of one-half inch spruce, 8 inches wide. May be tongue and groove or with a space of one-half inch left between planks, cockpit to have a bent rail of oak one-half inch thick and 5¼ inches deep. On the inside of the cockpit rail near the bottom nail and glue a strip of oak or spruce 3-4x3-4 inches. This will act as a sill upon which the outside end of the cockpit floor can be nailed. If this is done a strip of wood must be fastened under the backbone where it comes in contact with the runner-plank to make the center and outer edges of the cockpit floor set evenly on the runner-plank.

First nail your cockpit flooring on to your backbone, giving the contact parts a coat of hot glue. Make a one-curve pattern, as all four end curves of cockpit are the same. The center part is straight. Mark and saw out the

flooring to shape shown on Plate II., No. 1. Screw on one end of cockpit rail, bend in shape around flooring, and screw the other end in shape. Do not forget to let the rail protrude three-fourth inch below under side of flooring to receive strip which acts as sill for the flooring, and which is fastened to the lower inside edge of the cockpit rail. (Plate II., No. 2).

Insert at the ends of the rail where they come in contact with the backbone, a three-cornered piece of wood to prevent dirt and snow from accumulating in the corners.

RUNNERS

These must be of quartered white oak. The shoes of soft cast iron should have a cutting edge of about 45°. Dimensions of fore runners: Length over all, 4 feet; depth 6¼ inches including wooden shoe; wood 3¾ inches high at center by 2⅛ inches wide; shoe 2½ inches deep. Plate IV.

The shoes are secured to the runners with four machine bolts having hexagonal heads, with the exception of the center bolt, which is sunk in the wood and has a screw head made by filing the hexagonal head round and sawing a

screw slot in it. After this is screwed down snug it should be capped with a wooden plug to keep out water. (Plate II. at 1, and Plate IV. at M.) These plates show this bolt with four runners, as well as the rudder runner midsection.

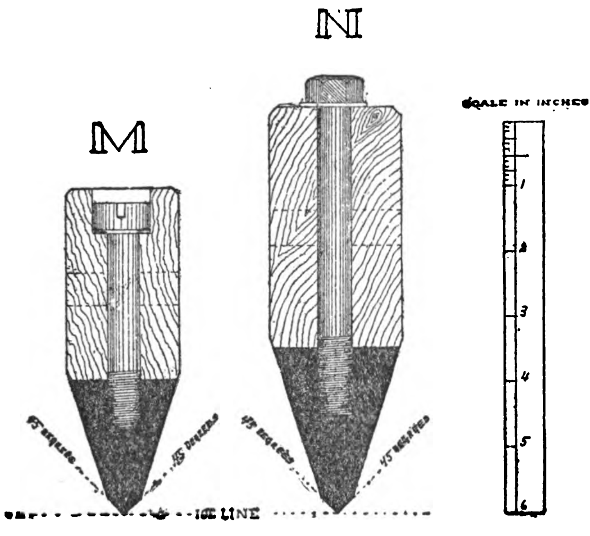


PLATE IV.—Section of runners. Steering runner at left.

The rudder runner is 2 feet 9 inches long over all; wood 3 inches deep and 1¾ inches wide; shoe 2 inches deep. The runner is pierced by three machine bolts, two with hexa-

gonal heads and one with screw head sunk in the wood as in the case of the forward runner. (Plate III., H and Plate VI., M). The pivot bolt of the fore runnners by which the runners are fastened to the chocks are ⅝ inch carriage bolts—nuts on outside of the chock equipped with a cotter pin to prevent its becoming loose. In Plate III., draft I, a brass plate is shown sunk flush with the cheek of the runner to prevent the riding-bolt from chafing the wood of the runner and enlarging the hole. These are placed on both sides of the forerunners as well as on the after runner. The center of the riding bolt should be 1 foot 5½ inches forward of the extreme aft end of the fore runner and 11½ inches forward of the after end in the case of the rudder runner. Place washers on all machine bolts holding runner shoes in place.

CHOCKS OR RUNNER-GUIDES AND BOLTS

The chocks are four in number and are made of ¼-inch white oak. Only the best will do, as a great strain is put on the chocks when the boat lifts on one runner in a strong breeze. (Plate III, A, B, and C. Plate II, Nos. 4 and

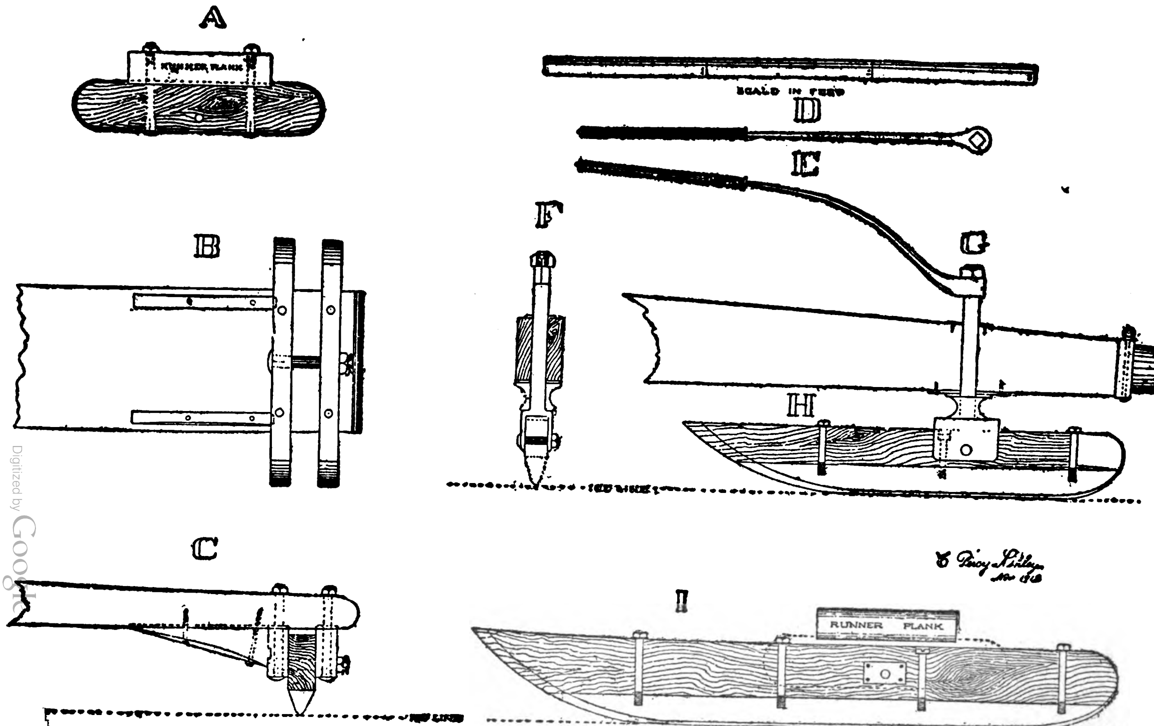


Plate III.—Detail of runners, chocks and steering gear.

5). Dimensions: Length 1 foot 6½ inches; depth 4 inches; width 1½ inches.

Chocks are sunk in runner-plank ¼-inch and glued. The ends are rounded off as shown in Plate III., A. Each chock is bolted to the runner plank with two carriage bolts, the thread of which is 9/16-inch diameter. Each of the inside chocks is reinforced by two oak braces which are rabbeted to the inside of the chock and sunk ¼-inch into the runner plank. These braces are secured with glue by two lag screws. See Plate III., B. and C.

SPARS

The spars in the case of this ice-boat are solid. Only clear, straight grained spruce should be used. The mast may be obtained either from a stick or from a joist. The boom and gaff and jibboom must be made of spruce joist, free from knots.

The dimensions of mast: Length 17 feet 6 inches; diameter at head 3½ inches; at center 4½ inches; at heel 3 inches. Boom; Length 4 feet 2 inches; diameter 3¾ inches at center, ¾ inches at ends. Gaff: Length 10 feet; iameter 3½ inches; 2½ inches at ends. Jib-

boom: Length 5 feet 10 inches; 1¾ inches at center and 1¼ inches at ends.

The mast is fitted with an iron collar at head 1 inch wide by 1/16 inch thick, having a U-iron of 5/16 inch diameter riveted into it. (Plate VI, No. 10.) Other mast fittings, shoulder cleats, and gooseneck described above. At outer extremities o f boom, gaff and jib-collar 1½x⅛ inches. A slot is cut in heel of mast to receive the mast step which is shown in detail on Plate VI, Nos. 21, 22, and 23. At outer extremities of boom, gaff and jib-boom fit a U-iron to act as a point of attachment for the sheets.

RIGGING SPECIFICATIONS

All standing rigging, except the bobstay, is ¼-inch diameter galvanized steel yacht rigging, having six strands and a hemp center, seven wires to the strand. Approximate breaking strain—3 tons. This gang of rigging comprises the four runner guys forward and aft, two shrouds, and the jibstay. For the bobstay use cast steel wire rigging of 5/16-inch diameter. Peak halyard bridle and becket for throat halyard: 5/16 inches diameter steel

yacht rigging having six strands and hemp center, each strand containing twelve wires with hemp core.

Hemp is best for all running rigging. For the halyards use ⅜-inch diameter, 12-thread Manila 3-strand bolt-rope, 21 feet to the pound. Jib sheet: 5/16-inch diameter 4-strand manila 33 feet to the pound. Main sheet 7/16-inch 4-strand manila, 17 feet to the pound.

BLOCKS, TURNBUCKLES, BULLS EYES AND CLEATS

The running rigging demands five bronze blocks having a sheave to take ⅜-inch diameter rope. Peak halyard blocks: one block with bridle attachment, one block with becket and shackle. Throat halyard blocks: One block with becket and eye, one block with shackle. (Plate VI, No. 10). There are five turnbuckles: four galvanized wrought iron turnbuckles with cotter pins, eye, and shackle; diameter of screw ⅜-inch, breaking strain 3 tons. These are fastened to the runner plank strap and are used to tighten up the wire runner guys.

One turnbuckle same style as above for the bobstay.

There is no shackle for the jib stay as it is fastened to the U-iron at the nose of the backbone.

Under no circumstances use a turnbuckle which is not fitted with cotter pins or check nuts. Four bulls-eyes, ½-inch inside diameter, for the mainsheet; two bulls-eyes ⅜-inch inside diameter for jib sheets.

The cleats are five in number. At foot of mast on the backbone, the cleats for the halyards may be most conveniently located on the backbone—the peak and jib halyard cleat on one side, and the throat halyard cleat on the other. The cleats for the sheets should be placed farther aft where they can be reached by the helmsman. Four and one-half inches over all is the most suitable size for cleats. Use the boat cleat pattern if you buy galvanized iron cleats. They can be easily made, however, of oak, maple, or hickory.

STEERING GEAR

Full details are shown in Plate III and V, the rudder post and crotch being in the latter. The post is 1⅛ inches diameter, and is 10 inches long from tip of thread. Square head

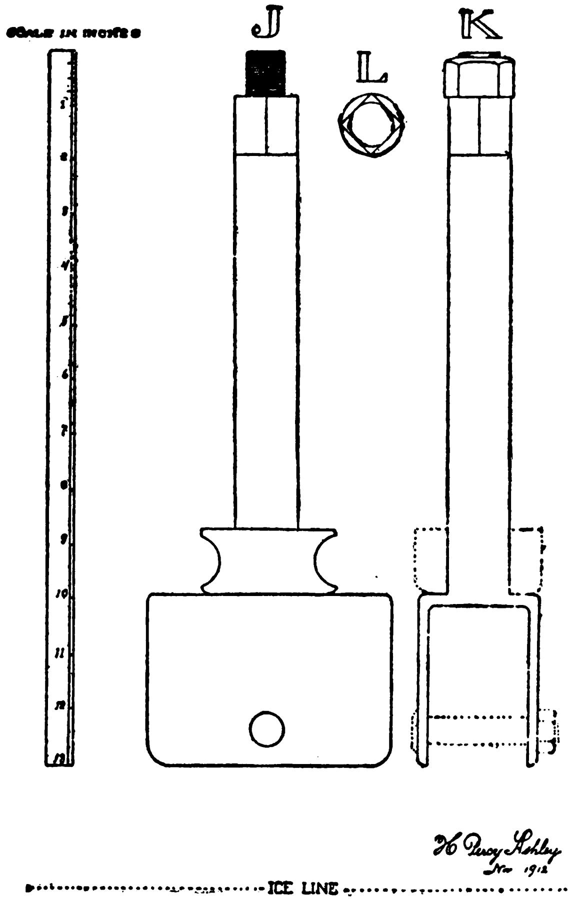


PLATE V.—Rudder post details.

for tiller 1 1/16 inches on the side and 1 inch deep; thread for cap nut ¾-inch diameter. The fork is made of 3/16-inch diameter iron 4½ inches long and 3⅛ inches deep. Inside width of fork 2 13/16 inches. The shoulder which is shown above the fork in Plate V, J and K, is simply a 1⅛-inch diameter octagonal iron nut with the thread filed out. It is welded in place along the upper side of the fork.

The rudder posts must be finished smooth (either turned or filed) and fitted snugly in the holes bored through the backbone. There are two plates, one on the upper and one on the lower side of the backbone to insure a snug fit. The formation of the rudder post plates is shown in Plate VI, Nos. 6 and 7.

The tiller is 2 feet and 6 inches long and has a diameter of ½-inch at handle, which is wound with ¼-inch braided cotton rigging. The tiller gradually increases in diameter ending in a square head, inside measurement of which is 1 1/16 inches along the face. Do not taper the square on rudder head or tiller, but keep them straight.

Tiller is shown on Plate III, at D and E, and rudder post head at G. A rubber washer may be slipped on the rudder post to carry

the weight on the backbone and to serve as a cushion.

IRONWORK

This is shown in detail for the hull and rigging in Plate VI. Numbers 8 and 9 are the runner-plank guy straps to which fasten the turnbuckles for the runner plank guys. This is a strip of iron ¼-inch thick, 11¼ inches long, 1¼ inches broad, pierced with five holes. The plate fits on the *under* side of the runner plank and the eyebolt which goes through the center hole carries the turnbuckle for the shrouds. It is ½-inch diameter.

Detail of masthead rigging is shown in No. 10.

Nos. 11 and 12 show the handrail of oak, 2⅞ inches x 1½ inches. It is easier as a rule to build this rail up out of the strip and three blocks, than to cut it from a single piece of oak. No. 13 shows detail of head rigging. The collar is of 1/16-inch iron, 1¼ inches deep and sunk flush with the shoulder. A U-iron 5/16-inch diameter is riveted to the plate at lower side, No. 15.

Nos. 16 to 20 represent detail of heel of

backbone with plate 1/16-inch thick and 1 inch wide sunk flush, to which is fastened turnbuckle for tightening bobstay. The drawing also shows bulls-eye for main sheet.

Nos. 24 and 25 show saddle iron which secures backbone to runner plank as described above. It is ¼-inch wide and ⅛-inch thick. A simple form of saddle is to take a ½-inch iron bar and bend to shape of backbone. Thread for nuts before bending.

SAILS

When you write to the sail-maker, send him an exact copy of the drawing shown on Plate VII. State that the sail is to be cross cut, of a fair quality of seven ounce duck. The mainsail should have one row of reef points, and the jib must be equipped with snap-hooks to take the one-quarter inch diameter jib stay. The leach of both jib and mainsail should have a draw cord, but not be roped in with a bolt rope. Dimensions as follows: Mainsail: hoist, 11 feet, 6 inches; boom, 13 feet, 7 inches; leach, 20 feet, 9 inches; gaff, 8 feet, 6 inches. Diagonal from jaws of gaff to clew of mainsail, 16 feet 8 inches. Gaff to have a peak of 65

degrees. Jib: head, 11 feet, 9 inches; foot, 5 feet, 6 inches; leach, 10 feet.

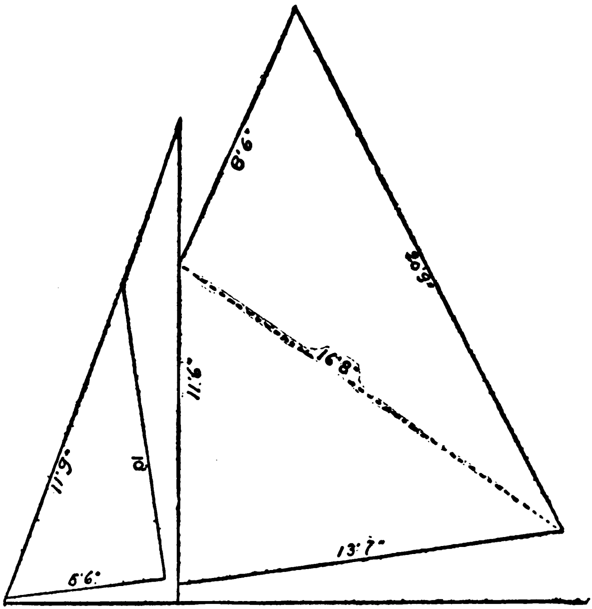


PLATE VII.—Sail plan.

RIGGING DETAILS

Spliced loops are required for shrouds and jibstay at masthead, and for eye in turnbuckles which are equipped with ¼-inch thimble. The

same for runner plank guys, all of which terminate in loops—one end passing over the nose or heel of backbone and the other riding on thimble in turnbuckle. All splices to be covered with electric tape served with cord and painted white, loop to remain bare. If you cannot get the wire splicing done, the loops can be secured by winding the two parts with copper wire and soldering, though this does not make nearly as neat or as strong a job. It is much better that the loops should be spliced.

The bulls-eyes through which the main and jib sheets run may be lashed in place with marline or secured by beckets. Wooden mast hoops are preferred, though iron ones may be used.

For details of runner shoes see Plate IV and Plate III, I. The pattern must be followed exactly, as there is a fore and aft downward curve of 1/8-inches deep directly under the riding bolt. This rocker enables the boat to turn without chewing up the ice, and is essential. Very soft cast iron is the only sort which will do, as noted above. When you get your shoes from the foundry smooth them with a coarse file, finish with a fine one and then polish with emery cloth wrapped over a smooth piece of

flat iron. A good scheme is to have the wooden part of the runners and chocks cut out by a steam band-saw, as it will save much labor.

When the boat is finished do not hesitate to use sand paper. A good finish is a coat of filler followed by a coat of spar varnish, using mahogany stain for the cock-pit rail. Use only spar varnish for the spars. A coat of light lead colored paint for the hull, with a second coat of claret colored paint makes a durable coating for the hull. All iron work should receive two coats of silver-bronze power mixed with banana oil.

It is an excellent idea to keep the ice-boat supported by saw horses, raised above the ice at night, as a boat left on the ice will sink its runners and necessitate a great deal of labor in working them free next day before one can get under way. It is also a good idea to remove the steering runner to prevent unauthorized use of the boat.

ESTIMATE OF COST OF ICE-BOAT

Bolts	$ 2.00
Rigging	16.00
Wood	20.00
Sails	15.00
Iron work	15.00
Paint	2.00
	$70.00

CHAPTER IV

Specifications for Three Hundred and Fifty and Four Hundred Square Footers

(Plans and drawings by courtesy of the Rudder Pub. Co.)

THE ice-yacht class designed to carry 350 square feet of canvas is one which has been coming into great favor of recent years. It is a racing boat, pure and simple, with the center of effort on the sails well forward and rather high, producing a racer which requires the helmsman's constant attention, but which is probably better suited for its work than either the larger or smaller class—representing, as it does, the happy medium between the big fellows which need a heavy crew and the small single handers.

Dimensions appear on all of the plans published herewith except in the case of the detail drawings, where a scale of reference will be found.

STRUCTURAL FEATURES

The backbone in this type of ice-yacht is a composite structure of a boxlike form, being made up of two side strips, a top strip, a bottom strip, and a number of filling blocks to

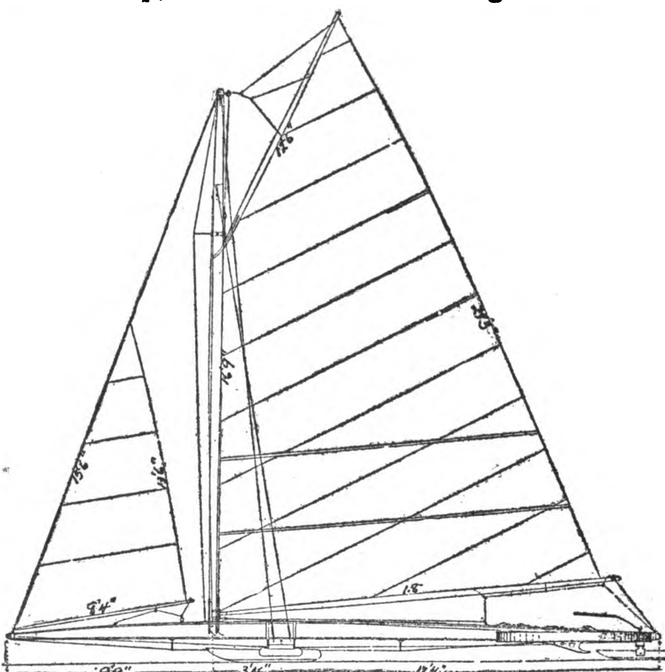


Plate I.—Sail plan and measurements of ice-yacht.

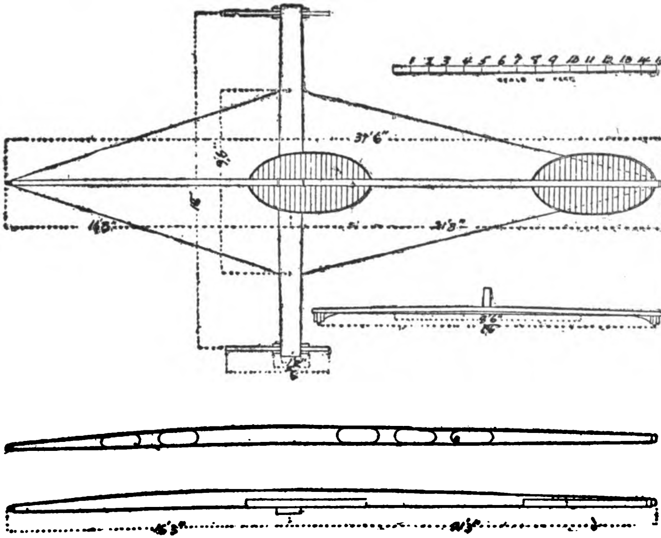


PLATE II.—Detail of backbone and runner-plank of 350-square footer.

which the strips are secured with glue and brass screws. The glue should be applied hot and the various strips fastened to the filling blocks with screws before the glue has had time to cool.

This backbone has the following dimensions: Length, over all 31 feet 6 inches; height (at center) 9½ inches, at forward end 3½ inches, at after end, 5 inches. Width at the mast is 5¾ inches. This full width is carried aft from

the mast to the heel, but the backbone tapers forward of the mast to 3½ inches at the nose.

There are eighteen filler blocks (see detail drawing) which give the backbone its form. The one directly under the mast is 8½ inches long; block at runner-plank 2 feet 3 inches long, with struts 3 inches wide at either end; block at forward end of cockpit 8 inches long; block at forward and after ends of backbone 1 foot 8 inches long. All other blocks are 5 inches long. All other structural features of this boat are similar to the 200 foot class, a detailed description of whose construction will be found in chapter III.

MATERIALS

Clear, straight grained spruce 1⅛ inches thick is the best material for the side strips of the backbone. For the top and bottom strips use seasoned white oak ⅝-inch thick. Filler blocks are of basswood.

For the runner-plank it is preferable to use seasoned basswood having the heart on the upper side. This will give the plank a slight upward arch at the center which may be increased by planing off the edges on the under

side, beginning at nothing at the ends and taking off 1¼ inches at the center. This arch will give the forward runners a desirable resiliency in passing over rough ice. Runner girders (or chocks) and brackets are of quartered white oak. (See Plate 3).

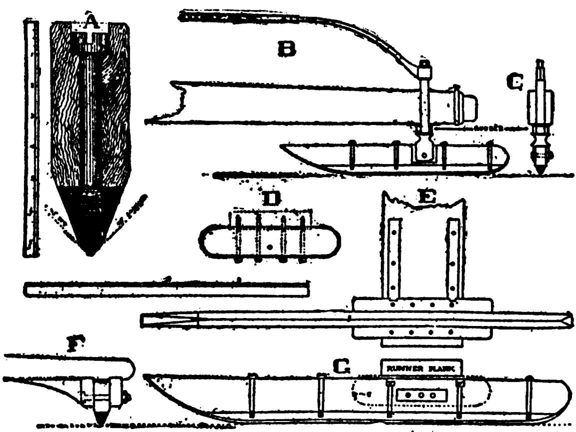


PLATE III.—Detail to scale of runners of 350- and 400-square footers.

Seasoned oak is best for the cockpit, with ash or hickory rail; and quartered white oak should be used for the runners—the runner shoes being of Swedish cast-iron.

Hollow spars *only* are suitable for this type of ice-boat. The best woods are Oregon pine

and spruce. The basswood and white oak mentioned above are becoming so hard to obtain in many parts of this country that other woods are being substituted for these—butternut, ash, spruce and Washington fir being among the

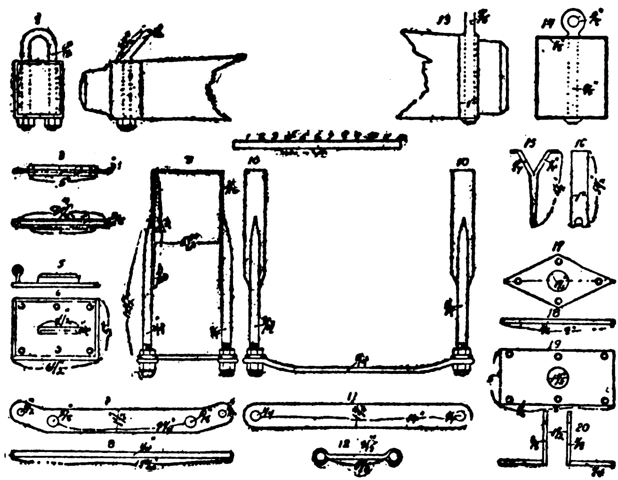


PLATE IV.—Detail of ironwork of 350-and 400-square foot classes.

Reference—Nos. 1 and 2, iron nose band; 3 and 4, jib traveler; 5 and 6, maststep plate; 7 and 8, toggle iron to hold eyebolts for shrouds; Nos. 9, 10, 11 and 12, backbone saddle; 13 and 14, iron heel band; 15 and 16, bobstay spreaders; 17 and 18, upper plate of rudder port; 19 and 20, lower plate of rudder port.

most popular. Of these butternut is the best. Ash does very well for the runner-plank, as it has the necessary combination of resiliency and toughness; but it is best, if possible, to retain the oak cap and understrip for the backbone and also the white oak runners, chocks and brackets, which are subjected to a great strain. The use of spruce and fir is permissible only when no hard wood can be obtained, as it will produce a boat which is rather too limber.

All standing rigging should be of plow steel wire rope, having seven wires to the strand. Diameter of shrouds about 5/16 inch, runner-plank guys, 9/32 inch, bobstay, 3/8 inch, martingale stay, 1/4 inch.

All running rigging is of steel; throat and peak halyards, 3/8 inch diameter; jib halyard, 1/4 inch diameter, with twelve wires to the strand and hemp core.

All halyards should have jigs on the standing end and the luff of both sails must be made with wire bolt ropes to prevent stretching. A taut lift is an absolute essential for speed. The mainsheet is of 5/16 inch diameter, galvanized or bronze tiller rope and has a jig also. Jigs for all halyards and mainsheet are of four strand, manila bolt rope of 7/16 inch diameter.

Jib sheets are manila, 5/16 inch diameter (nine-thread rope).

Turnbuckles for shrouds and stays are best of bronze, with shackles at both ends, and of proper size to match rigging. As no two boats will be rigged precisely alike, a certain degree of latitude must be allowed in connection with these specifications. Any reputable marine hardware house can furnish the necessary equipment to match wire rigging of a given size.

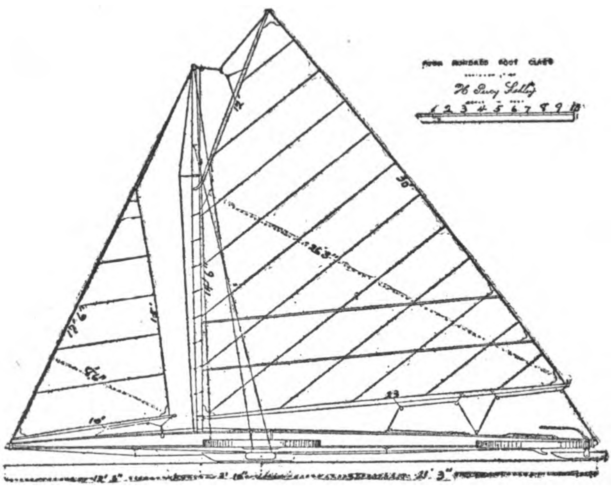


PLATE V.—Sail plan and measurements of 400-square footer.

Patterns for all ironwork will be found in the plans.

400-SQUARE-FOOT CLASS

The ice-yacht of the 400-square-foot sail area class shown in the accompanying plans differs from the 350-square-foot class just described chiefly in sail plan and accommodations. The sail plan of this design is considerably

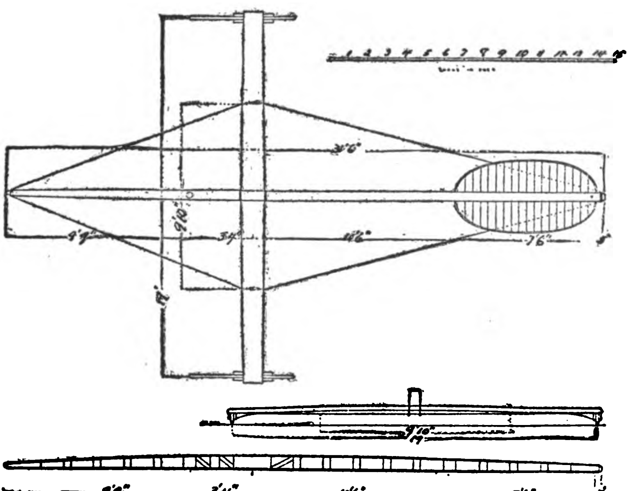


Plate No. 2. Deck, Backbone and Runner Plank Details

PLATE VI.—Dimensions and plans of 400-square-footer.

more squat, with the center of effort relatively lower than in the case of the other boat.

There is a second cockpit situated at the intersection of runner-plank and backbone, which adds considerably to the boat's stability when occupied.

The same materials may be used in this boat as in the 350-square-footer, and the method of construction is identical. All measurements will be found on the accompanying drawings or may be taken off the subjoined scale.

For full instructions upon the building of the typical ice-boat see Chapter II, in which all construction features are discussed in detail.

CHAPTER V

How To Build An Ice-Boat For $60

BY H. PERCY ASHLEY

WHEN first taking up ice-boating as a sport the majority of men usually start with a boat of small size and one that they build themselves, or at least plan out themselves and have built under their supervision. In spite of this apparent demand for such small boats suitable for the novice, there seems to be a dearth of well designed, yet cheap and staunch ice-yachts; and it is with a view to supplying this need that I have designed the little boat shown in these plans—one which can be built, exclusive of the cost of labor, for about $60. The construction is very simple and is fully described here. As the explanation of details of construction of some of the parts, such as runners, cockpits, etc., are contained in the preceding chapters, and are practically the

same in all ice-boats, it will not be necessary to repeat them here, it being presumed that the reader has assimilated the information which has preceded.

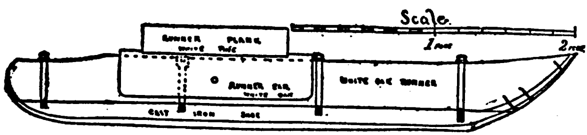
The first essential is wood. Two good sticks are required. One, the backbone or center-timber, should be well-seasoned pine, measuring in the rough 22¼ feet by 10 inches by 4½ inches. Take this stick and tack two battens on it (long strips of pine or any soft wood). The first batten tack on the bottom of the backbone in the rough, and give it an upward curve of two inches, the highest part being at the contact of the runner-plank. The upper curve is 5½ inches with highest part at mast. Then taper the extreme ends down to four inches aft and 3½ inches forward. This gives the proper curve to the backbone. The forward part is fitted like the end of a mast, with the two loops of the bowsprit stays leading to the runner-plank.

Now that you have the backbone, the runner-plank, or heart of the ice-yacht, can be dressed into shape. The plank must be of more than well-seasoned pine.

Endeavor in selecting the wood to have the heart on the top side and in contact with the

backbone. This plank is 12½ feet long by 13 inches by 6 inches.

Place battens on your runner-plank, as you did on the backbone to get the curve, allowing 4¾ inches at the center and 2 inches at the ends. Round up the lower curve next to the ice, and have it sawed out to these marks.



Detail of runners, to scale.

As you have now gotten your runner-plank in good shape we will start on the runners. The three runners are of seasoned white oak, of the finest and hardest grade. The fore-runners measure 3¾ feet by 4¾ inches by 2¼ inches. The rudder is 2 feet 10 inches by 3½ inches by 2 inches. These are held in place, the fore-runners by one-and-a-half-inch thick oak chocks which are bolted to the extreme end of the runner-plank, as in the boat described in Chapter III.

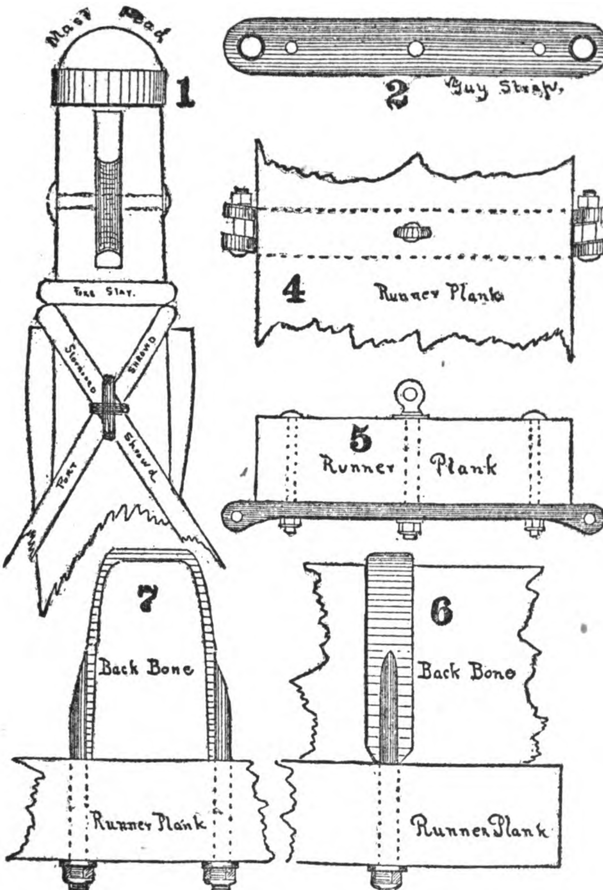
The shoes of the runners are made of soft cast-iron, having a cutting surface in mid-sec-

tion of ninety degrees. They have a slight rocker curve fore and aft in contact with the ice, say one-eighth inch at the center, gradually quickening at the ends.

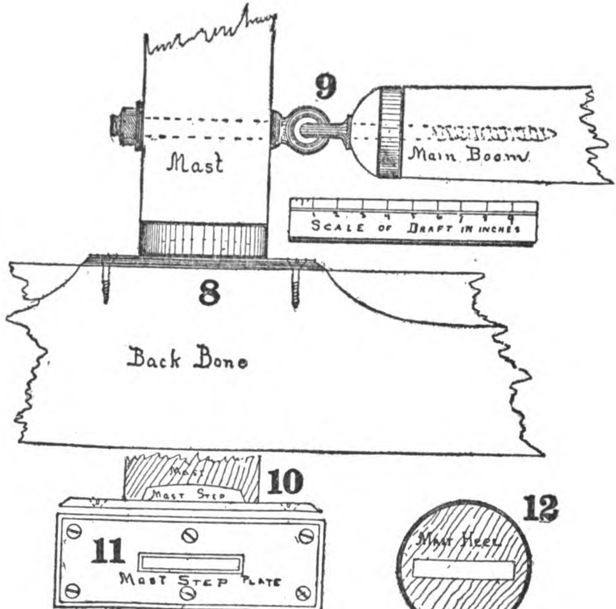
The fore-runners hang on a pivot-bolt allowing a swing over uneven ice, while the rudder-runner swings in the crotch of the standard, on which is screwed the tiller.

The iron shoes are pierced by bolts on their upper surfaces with a corresponding thread and securely set up to the oak runners as before described. In case a true finish is not obtained between the iron shoe and the oak of the runners, a piece of cotton flannel, well soaked in white lead and inserted between the contacting surfaces will insure it.

The iron work in an ice-yacht is a very important item in the construction. The backbone at each end has a collar. At the after end it is pierced by an eye-bolt, to which is fastened the main-sheet. At the point where the center timber crosses at right angles the runner-plank, a U-shaped iron, ending in a thread with bolts, passes through the center of the runner-plank and holds the backbone. It is 1½ inches by ¾-inch. (See Figs. 6 and 7.)



Details of iron work.



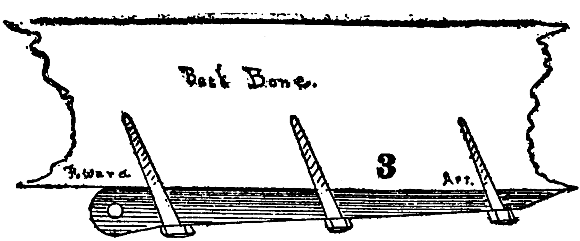
Details of mast-step.

In the diagrams of the iron work, 1 to 12, the construction is clearly shown to scale.

No. 1 shows the masthead with iron band on top, the slot up and down cut to receive the peak halyard pennant, with sheave and pin, also fore-stay and shrouds saddled over mast-head.

No. 2 is a simple stay-iron known as guy-

strap, that fits on the underside of the runner-plank at meeting point of the shrouds, and connects with the bowsprit shrouds, and back-stays; 4 and 5 show a more elaborate construction of the same. No. 6 shows the runner-plank strap, fastening backbone to runner-plank; 7 is the same head-on. Eight is the mast stepped on backbone. Plate 9 is the main-boom joined to mast with interlocked eye-bolts. Ten is mast-step plate, side view. Eleven is a deck view of mast-step plate. Twelve is the heel of the mast, giving idea of how the slot is cut in the mast to receive mast-plate. No. 3 is the gammon iron which is the inboard end of the bobstay, situated just forward of the runner-plank. The three lag-screws are raked forward to take the stress off the bobstay as set up with dolphin striker or bobstay spreader.



Gammon iron for inboard end of bobstay.

The fore and aft guys, ¾-inch steel wire, run from the end of the bowsprit to runner-plank and from the after end of the center-timber to the runner plank, going underneath the cockpit. They are fastened to the guy straps on the runner-plank with turnbuckles so that they can be set up taut.

The bobstay leads from end of the bowsprit to a point just forward of the runner-plank, is swayed down by a dolphin striker, and set up with a turnbuckle at the runner-plank end.

See that the runner-plank is exactly at right angles with the backbone and that its center is exactly 8½ feet aft of the end of the bowsprit. The steering-box, or large cockpit is formed of a flooring of pine 4 inches wide by ¾ inch, and is laid on at right angles with the backbone and securely screwed to center-timber. Around this is bent a strip of oak, 4 inches by a slack ½ inch, which is securely bent around the steering-box, finished by a beading on the inner contact surface with the cross-boards of the steering-box, or cockpit. The measurements are 8 feet by 3¼.

The dimensions of the spars are as follows: Mast 16⅛ feet, boom 17¾ feet, gaff 9 feet, jibboom 6¾ feet. The mast is stepped 7 feet

aft of the extreme end of the bowsprit, on a plate with raised surface fitted to a slot cut in bottom of the mast. The peak halyard is a flexible wire rigging rove through the top of the mast, in a slot in which is fixed a brass sheave, the halyard ending on deck with a "jig" and on the gaff with a bridle. The throat halyard is the same, only rove with a block at a point just above the jaws of the gaff. The jib halyard is rove, as usual, with a single and a becket block. The shrouds are passed over the masthead with a spliced and served loop ending in turnbuckles and eye-bolt at the runner-plank (see plan of mast-head). The jib-stay is treated in the same way, minus the turnbuckle, but in its place is seized the end of the stay at the extreme forward end of the bowsprit, in an eye-bolt.

The dimensions of the sails are: Mainsail—Leach 23 feet, boom 17 feet, hoist 10 feet, gaff 8¾ feet; jib on stay 12¾ feet, hoist 10½ feet, foot 6½ feet. This sail should be machine-stitched, double-bighted with a bight swing of 9 inches, roped on three sides and a drawing pennant in leach. The material is 6½-oz. drill.

Below is the approximate cost of the mate-

rials for the small, up-to-date, ice-boat. These prices may vary somewhat in different localities, but at the present range of prices will be fairly accurate.

Wood, including backbone, runner-plank and cockpit	$11.45
Turnbuckles	5.25
Iron work and rudder standard	6.25
Runner castings	2.70
Mast hoops	1.10
Sail (material only)	13.00
Steel rigging	5.25
Blocks	4.25
Spars	6.00
Bolts and eyes	1.20
Rope	1.05
	$57.50
Spar varnish and filler	2.50
	$60.00

The main sheet requires one double and one single block; the jib sheet, two single blocks; the peak halyard, one single sheave block and one single becket block; the peak halyard jig, one single block with becket and one double block; throat halyard, one single and one becket block. A good grade of galvanized blocks, to take 3/8 manila rope, giving plenty of play for the rope, or a cheap but strong grade of ash block is required.

After the boat is finished give her a coat of

filler and sandpaper, then finish with spar varnish. The hand rail on the backbone, just forward of the standard, is of oak, set in place by small lag-screws.

In selecting the standing rigging it should be ¾-inch crucible steel and the halyard ⅞-inch pliable steel rigging.

A martingale or strut stay, running from the masthead and over a spreader at the forward side of the mast will strengthen the mast.

CHAPTER VI

An Improved Heavy Weather Type Of Ice-Boat

BY. DR. WM. M. STANBROUGH

THOUGH many improvements have been made in the construction and finish of ice-yachts, including a great saving in the weight of material, practically all of the changes have been along conventional lines. With the exception of varying rigs, experiments have not produced anything beyond the conventional boat with cockpit aft over the rear runner or rudder, so that any live ballast that is necessary has to be carried on either runner-plank or on a grating between it and the back-bone.

These old boats have several inherent defects which have not been entirely overcome, and which will be taken up in detail later on in this article, the principal one being the difficulty

of holding them down on the ice in a breeze and the necessity of carrying a crew to overcome this tendency to lift in heavy puffs.

Some six years ago, however, after sailing a boat of the old type and upsetting or "flickering" a number of times I began a series of experiments with boats built on somewhat different lines, and finally produced an ice-boat of an improved type, which I call the *Heavy Weather*. This boat was built to the 250-foot class, a class which is usually sailed with a crew of one and where the distribution of the weight is a prime requisite, though the principle involved in its construction would apply equally well to boats of the larger classes.

Working on the theory that the weight of the crew carried in a cockpit located over the rudder added a great deal to the dead weight carried and, at the same time, was of little or no use as ballast, I have demonstrated by the use of a pair of platform scales under the rudder and runners, that the weight of a man weighing 200 pounds was distributed as follows: One hundred and sixty-eight pounds of the weight resting on the rudder and only 32 pounds on the runners, where the weight of the ballast necessarily counts for most. This 32

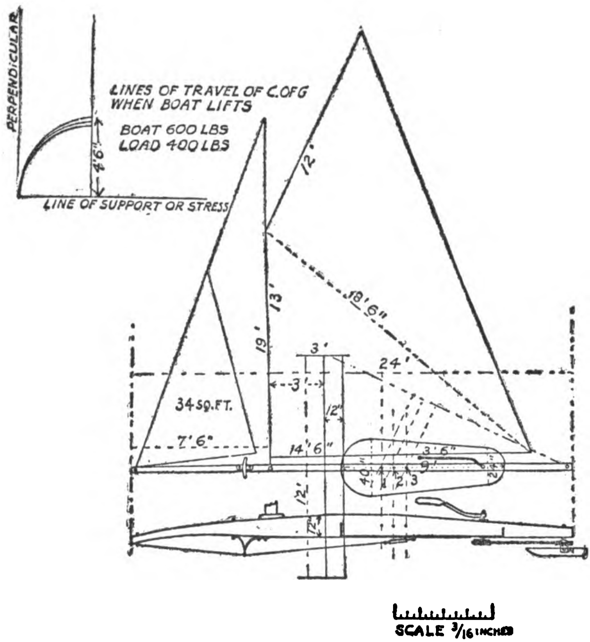


FIG. 2.—Plans of improved ice-boat, showing the position of cockpit and the locations of the centers of gravity. No. 1, center of gravity of boat alone; No. 2, center of gravity of boat and load; No. 3, center of gravity of weight alone.

pounds on the runners was also unevenly distributed, 10 pounds being on one runner and 22 pounds on the the other, owing to the position in the cockpit in which the helmsman lay. From this it will be seen that the weight of the

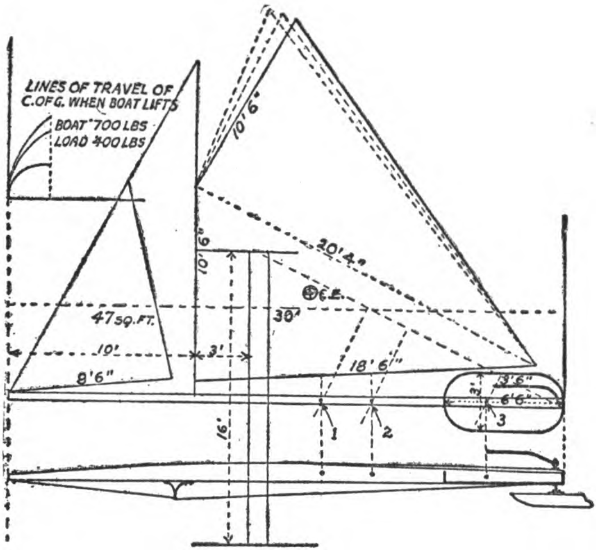


FIG. 3.—Old-style ice-boat. No. 1 represents center of gravity of boat; No. 2, center of gravity of boat and load; No. 3, center of gravity of load. Note the difference in position of these points as compared to those in the new style.

skipper is of very little value, in the old type, as far as ballast is concerned, amounting to 168 pounds load and 32 pounds ballast. By moving the cockpit forward along the backbone, this weight can be more evenly divided between the three runners, giving considerable

additional ballast with the same load, besides having many other advantages.

One of the principal advantages derived is that it brings the centers of gravity of the boat and load more nearly together, as is shown in the accompanying drawings of both the old and new types (Figs. 2 and 3). In these drawings the center of gravity of the load and the center of gravity of the boat and load together are shown. In the new type these are brought within a few inches of each other, whereas in the old type these were widely separated. In addition to this, when a boat lifts in the breeze the weight in a cockpit situated over the rudder is very quickly lifted until it is directly over the line of support, which is usually indicated by the stay or guy between the runner-plank and the after end of the backbone. Naturally, the more nearly this weight is thrown directly over the line of support the less value it has as ballast, and if it is thrown beyond the line of support as the windward runner lifts it is adding just that much to the pull to leeward, helping the boat to capsize. With the load well forward on the backbone, it is, of course, further from the line of support, where it is practically impossible for the windward runner-

plank to lift high enough to throw the weight outside of this line of support. This point is illustrated in Fig. 1. Even at a heel of 45 degrees the load is not thrown outside of the line of support when the cockpit is placed where it is in this new type.

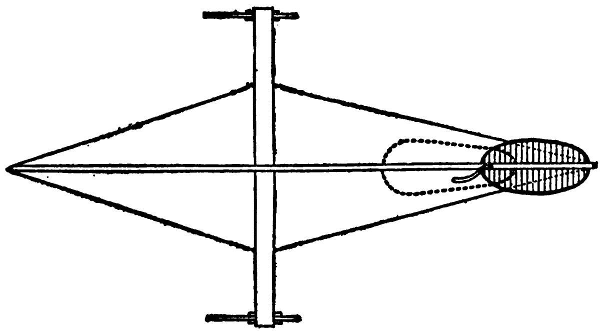


FIG. 1.—Plan of an ice-boat, showing the relative position of the load in regard to the line of support, with the cockpit well aft, as in the old type, and further forward, as in the new type. At but a slight angle of heel the load in the rear cockpit would be thrown outside the line of support, represented by a line from the runners to the end of backbone.

Another advantage of carrying the weight farther forward instead of aft is in the ability to round a mark more sharply, or in a smaller radius of a circle, than in the old type. This is due to the fact that, in changing the direction of a boat's course in rounding a mark, the

greatest momentum, which would naturally be where the load is greatest, is not at the extreme after point. The center of gravity of the boat and load being farther forward, the thrust exerted thus comes more nearly amidships. This holds good in the various positions which the boat assumes in rounding the mark and in the varying angles at which the wind strikes the sails.

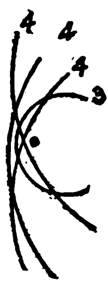


FIG. 4. — No. 4, the courses old boat must follow in rounding a mark; No. 3, courses new boat can follow.

The arcs which it is necessary for an old boat to take in rounding a mark are shown in diagram 4, and also the arc which the new boat can follow in rounding the stake. By having the centers of gravity close together and farther forward in the new boat, the momentum in turning the mark is largely taken up by the lee runner in the form of thrust. In addition, the getting of the weight off the rudder allows use of a runner so dull as to be dangerous in the old type. Here it is perfectly safe, and it is well known that a dull runner is somewhat faster than a sharp one. As the greatest amount of pleasure is in racing around a small

diamond course—half a mile from stake to stake, or about 2 miles for the course—it will be seen that this ability to turn corners sharply counts for a great deal.

By carrying the center of gravity of the boat and load farther forward, it is practicable to carry a higher sail plan than was possible with the older type, the center of effort of the sail being raised some 2 feet. The lower 2 or 3 feet of the sail along the boom do not give the same driving power as that part of the sail higher up, and the raising of the center of effort increases the efficiency of a sail plan of a specified number of square feet. On this new boat a hoist of 13 feet is not too great with a 12-foot gaff, as against a hoist of 10 feet 6 inches in the old type with a gaff of the same length, while the boom is shorter by some 4 feet. This should make for much greater efficiency in the sail plan.

Not only this, but a shorter runner-plank can be used with safety and the requisite square feet of sail carried with ease on a much smaller boat. For instance, the boat described herewith has 250 feet of sail and is but 24 feet long, with a runner-plank of 12 feet, while boats carrying this sail of the older type are

usually some 30 feet in length with a 16-foot runner-plank. The saving of weight in these smaller dimensions is easily apparent and an item to be reckoned with. Even with a higher center of effort and a smaller boat, the stability is greater, owing to the carrying of the weight more nearly amidships in the position it logically should occupy. This is shown by the ability of a boat I built on this plan to sail in weather in which the average ice sailor will not venture out, while in light airs a tall rig is of much greater value. This boat will sail with her runners on the ice in almost any weather.

One of the difficulties to be overcome in moving the cockpit forward was to get a satisfactory connection between the rudder and tiller. This was done by the use of sprocket wheels and a sprocket chain, one sprocket being placed on the rudder head just over the runner, while the tiller head ran down through the backbone five feet farther forward, with the sprocket wheel attached to the under side. For a 24-foot boat an ordinary sprocket chain, such as is used on a bicycle, was found amply heavy. There was almost no play, and the steering gear gave entire satisfaction. A drum and cable can be substituted in place of

the sprocket steerer and is equally as good as, if not better than, the chain and sprocket, and would probably be somewhat cheaper. Two turnbuckles are needed for either method to take up the slack, so that rudder and tiller will always be on a line.

The dimensions and specifications of this boat are as follows: Backbone—Of basswood in one piece, or butternut or yellow pine, although the lighter woods are preferable; selected of the very best grade, well seasoned and free from checks. It is 24 feet long by 12 inches thick in the center, tapering to 5 inches at the stern and 3½ inches at the nose, and is 4 inches wide.

The runner-plank is 12 feet long by 12 inches

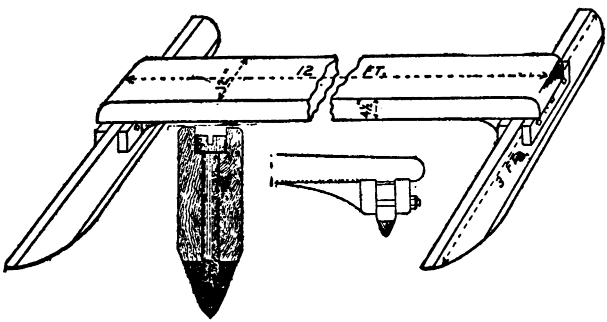


FIG. 6.—Details of runners and runner-plank.

wide and 4½ inches thick at the center, tapering to 2¾ inches at the ends. This runner-plank crosses the backbone 10 feet 6 inches from the forward end, while the mast is stepped 3 feet forward of the runner-plank. The runner-plank should be made of ash, butternut, or basswood. The runner chocks or guides are made of white oak 16 inches over all, 2 inches thick and 6 inches deep, and are sunk in runner-plank ¼ inch and fastened with glue and bolts through the end of the runner-plank. The runners themselves are 3 feet long by 6 inches deep, and must be of the very best seasoned oak. To these are bolted the cast-iron shoes, as shown on the accompanying diagram, planed to an angle of 45 degrees on the lower edge. The details of the rudder and steering gear are shown in the diagram. The rudder post and tiller post should be of galvanized iron 1¼ inches in diameter, with a shoulder with jaws at the lower end of the former 2⅞ inches deep, to fit over the rudder or after-runner. There is a shoulder between these jaws and the under side of the backbone, to which is keyed the after sprocket wheel. The tiller post runs through the backbone five feet forward of this, to the under side of which

is keyed the forward sprocket wheel, as shown in the diagram. The cockpit frames and coaming are of oak, while the flooring can be of white pine, basswood, or cottonwood.

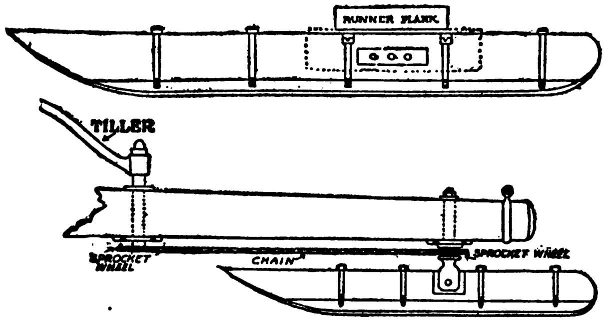


FIG. 5.—Details of runners and steering gear.

Along the center of the backbone inside the cockpit is bolted a hand rail for helping to retain one's position in the cockpit. The cockpit is 8 feet long by 40 inches wide at the forward end and 24 inches at the after end, with the coaming rounded at either end, or of a size and shape to suit builder.

A boat was built from these plans when it was found that in heavy weather the weights were a little too far forward. They were figured so in the diagram herewith for purposes of illustration, and while the boat sailed

well in moderate weather it would be well, if the boat was to be used in heavy breezes, to carry the cockpit a little further aft as she would need more weight aft, over the rudder. Building the cockpit one foot further aft would probably be more satisfactory for an all 'round boat.

The mast should be hollow, 19 feet in length; the boom may be solid, 15 feet long, while the gaff is 12 feet, 10 inches, and may also be solid, with bent jaws of oak or with a goose-neck and bronze band around the mast. The dimensions of the sails are as follows: Mainsail, hoist, 13 feet; head, 12 feet, and foot, 14 feet 6 inches; area, 206 square feet. The jib is 7 feet on the foot by 10 feet on the luff with an area of 34 square feet. As full sails cannot be carried at all times, it will be necessary to have a line of reef points in the sail.

The guys, from the nose to the forward end of the runner-plank and from the after end of the runner-plank on each side, should be of the best wire rope ¼-inch diameter with bronze turnbuckles. The martingale stay should be of 5/16-inch galvanized steel wire rigging, running over galvanized steel strut bolted to the under side of the runner-plank just forward of

the mast step, and set up with a turnbuckle. For the shrouds 1/4-inch steel wire is of sufficient size. The usual grade of bronze or galvanized fittings should be used throughout. Bronze turnbuckles should be used for setting up the stays and guys with a thread of from one-half to five-eighths of an inch.

The running rigging should consist of either wire or manila throat and peak halyards. If the former is used, it should be about three-eighths of an inch in diameter. Jib halyards may be of light stuff, either manila or the best grade of cotton rope. The main sheet should be of the best manila hemp about one-half inch diameter. Wire rope blocks should be used if wire halyards are decided upon. The usual number of blocks for a rig of this size will be required, four for the peak, if two blocks are used on the gaff, and two for the throat. The main sheet will require from four to six blocks, according to the manner in which it is rigged. After passing through the blocks at the outer end of the boom, it should be carried forward along the boom by blocks or leaders, brought down through a block on the backbone forward of the cockpit, and the ends spliced into a jig tackle stretched along the backbone and lead-

ing aft into the cockpit. This tackle can be made of a single block and becket.

To give the best finish the framework should be thoroughly sandpapered, given a coat of filler and varnished with two or three coats of the best spar varnish, being rubbed down between each coat. This will give an excellent finish to the boat.

Hollow backbones are in rather general use among the larger-sized boats, and while the using of such a one here would save some weight, on a boat of this size it would be hardly a factor worth considering if light wood were used instead.

The same principles and factors involved in this boat could, of course, be applied to larger sizes, and, I believe, would be equally effective. The only reason that I have described the smaller boat in detail and given her dimensions is due to the fact that there are more boats of this size likely to be built, and that in many localities a 250-class is sailed with a crew of one, making the disposition of the weight the principal factor in success.

In building a boat after this type, one would get a craft that should prove satisfactory in every way, both from the ability to handle

her with a small crew in any kind of weather, and if due regard is paid to lightness in construction, a boat that should be able to take the measure of nearly anything of her size.

[EDITOR'S NOTE:—Dr. Stanbrough has obtained a patent on this steering device as applied to ice-boats, but anyone desiring to build can probably get permission to use the device by applying to the author. Address Newburgh, N. Y.]

CHAPTER VII

The Ice-Boat With A Movable Backbone

BY DR. WILLIAM M. STANBROUGH

AFTER sailing the conventional type of ice-boat for a number of years I experienced the difficulty which most people find in keeping them "on their feet" in a good breeze, and after several capsizes due to inability to carry sufficient ballast to keep the windward runner on the ice without loading the boat down with unnecessary weight, I began to study the problem of greater stability and the design of ice-boats in general.

It was plain to me that the old conventional type had been brought to the highest point of perfection as regards lightness of construction, hollow spars, etc., and it was no use trying to build something to beat the best that the old type could produce by following the same lines.

I realize that an improvement in design must be the first step. Many people are afraid of

the old type when the wind starts to blow on account of the danger of the boat's becoming unmanageable when one runner lifts. Naturally, increased stability was to be desired; and with stability gained, the weight of the boat could be cut down on a given sail area, which should increase the speed.

After building a boat with the cockpit and load farther forward on the backbone, as described in the previous chapter, the idea occurred to me of a still better way to increase the stability and thus carry more sail on a given length. The idea is still one aiming to get the center of gravity to windward of the line of stress; this increases the stability without increased weight. I accomplished it *by utilizing the force of both lee and weather sail*—that is, trying to break the backbone in two at the runner-plank fore and aft of the point of lateral resistance, thus getting a forward or rigid part, and a rear or movable part to which the cockpit is fastened and moves with it. To bend, or warp, this backbone, a means of control is needed, and can be worked out successfully in several different ways. Such a boat can be made lighter for a given sail area and can carry a higher sail plan, which will be more

effective. The idea has worked out so well that I have applied for a patent on the principle, and allowance has been given.

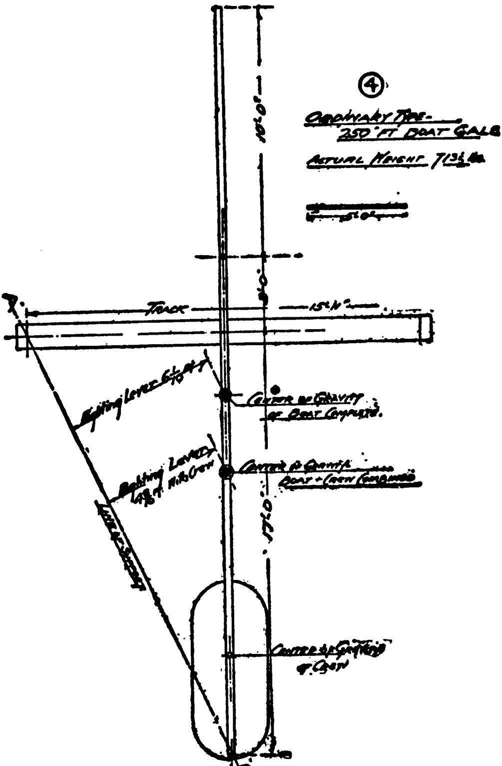


FIG. 1.—Conventional type of ice-boat. Actual weight 713½ pounds; 250 square feet of sail. Shows center of gravity of boat and of crew.

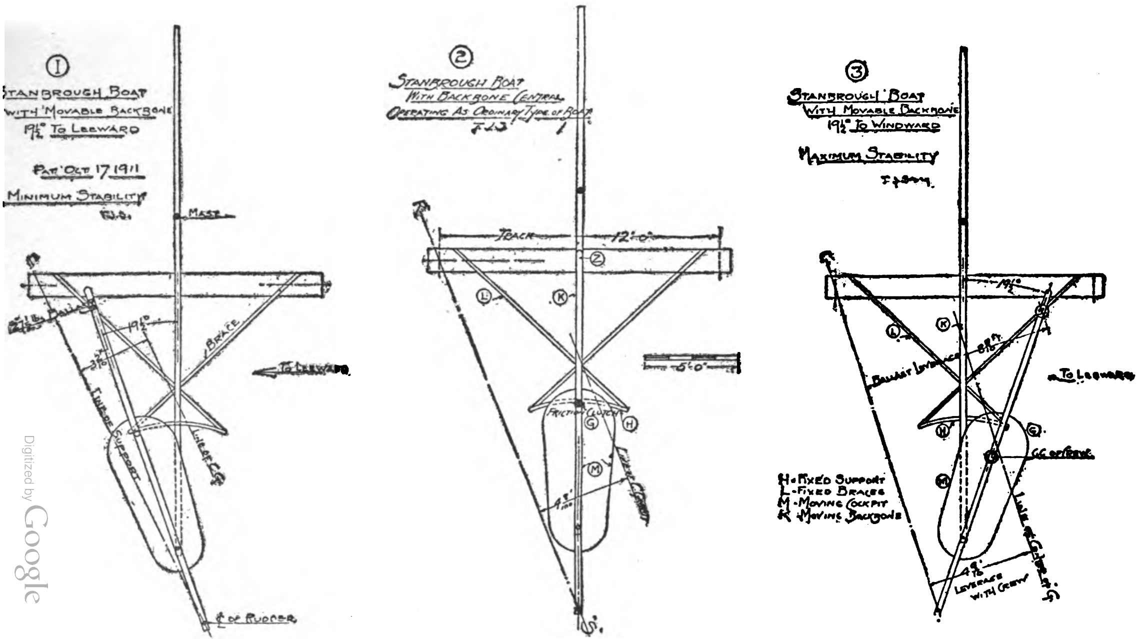


FIG. 2.—Plan of new type with movable backbone carrying cockpit and crew. Position 1, lever arm to leeward. Position 2, lever arm in center. Position 3, lever arm to windward. "G," center of gravity, boat and crew.

Figure 1 shows the conventional ice-yacht with rigid frame and with the center of gravity of boat, and of boat and crew worked out. Figure No. 2 shows my improved ice-yacht with the centers of gravity approximated, and with the additional improvement of a method of shifting these centers to windward of the line of support or stress by means of a movable or hinged after part of the backbone to which the rudder is fastened. By means of a lever the conventional equal sided triangle is changed into a scalene, or an unequal sided triangle. The long side of the triangle being to windward and the short side to leeward changes the keel from the conventional straight one to an obtuse angle, the shorter portion being at the stern as shown. (See Figure 2, position 1 and 3 showing movable part, or lever, in windward or leeward positions.) Figure 3 is a profile plan of the same boat.

It will be seen that by attaching a weight to the forward end of the lever, it can be moved to windward at the desire of the operator, or the movement of the lever can be made automatic by attaching the main sheet to the top of the rudder post, or at some other convenient point at the end of the movable part, where the pull

of the sheet will throw the weight at the other end of the lever up to windward; or it can be made semi-automatic by a lever and wire rope properly attached, the sprocket and chain, or drum and cable, being still used to control the rudder as in the *Heavy Weather* model described in the preceding chapter. In a light

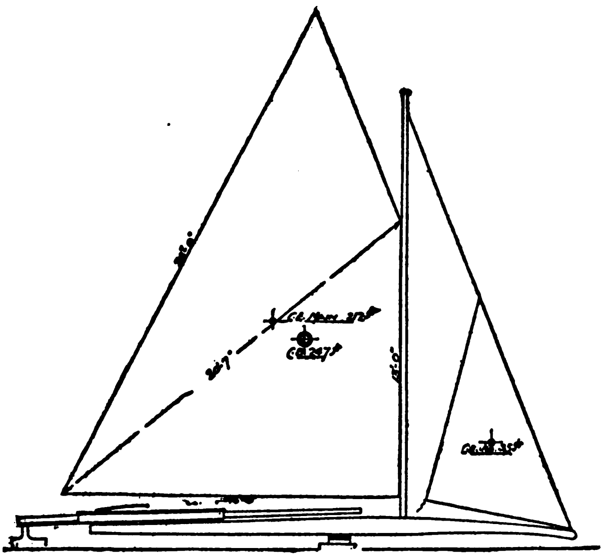


Fig. 3.—Profile of new type of ice-boat, with movable lever arm carrying cockpit pivoted on rigid keel or backbone. 247 square feet of sail.

wind if it is desired to have less weight on the windward runner, so that there will be practically but two points of support to reduce friction, this operation can be reversed and the weight shifted to leeward, with the result that the boat will move faster in a lighter wind.

As will be noted, the stability is increased by moving the rudder support to leeward, as the weight of boat and load act through the longer lever, and the weight of the entire outfit is turned into ballast, excepting the lee runner and the rudder, making it possible to use a smaller structure of very much less weight for the same sail area, thus increasing the safety, speed and pleasure of operating an ice-boat. In the boat under consideration in this article, the runner-plank was twenty-five per cent. shorter than in the regular type.

There are several other ways of moving this center of gravity to windward of the line of support, and the changing of the keel from a straight line to an obtuse angle is not essential. Some of these other methods will be spoken of later, but for the present we will confine ourselves to the model under discussion, showing its advantages.

In this new type it will be noticed that the

rigid backbone extends only to within about four feet of the rudder, the latter being carried on a movable keel or backbone, which is pivoted to the after end of the rigid backbone and has a long arm extending forward as far as the runner-plank. This movable backbone carries the cockpit, and its forward end has 27½ pounds of lead ballast.

It will be seen that with the pull the main sheet at the rudder (point D. Fig. 2) the long lever arm carrying the weight of crew and the ballast will be thrown up to windward, thus increasing stability.

The tables on the pages following show just what is gained in stability and what can be saved in weight with this type of boat as against the conventional one with the solid backbone. For comparison, the weights and figures of the conventional type are taken from the ice-boat *Gale,* where actual weights and figures were available, while with the new type of boat the actual weights of the various parts are given, showing a decrease of 27½ pounds, which is the amount of ballast added to lever arm to bring the total weight up to the conventional type of boat for the purpose of fair comparison. Centers of gravity of boat and crew are

also worked out. The three tables give the moments in foot pounds with the movable backbone amidship (as in the conventional type), at an angle of 19½ degrees to windward, and at an angle of 19½ to leeward.

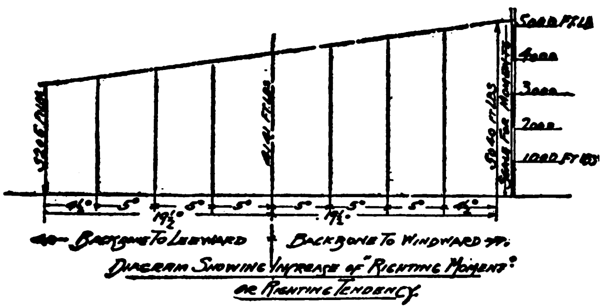


Figure 5 is a diagram showing righting moment for various positions between the extreme leeward and windward ones of the lever arm. A study of these tables shows an increase of nearly 200 pounds in righting moment between the new type of boat and the old type as exemplified in the *Gale*, yet the latter had a runner-plank of 16 feet as against 12 feet in my boat, and much heavier runners.

POSITION 1—MOVABLE BACKBONE TO LEEWARD

Item.	Weight, lbs.	Leverage about line EF.	Moments in ft. lbs. about EF.
Backbone K	166	5.3	880
Cockpit M	105	.8	84
Planks	95	5.4	513
Two runners	60	5.4	324
Mast	43	6.7	288
Boom	20	3.5	70
Gaff	10	5.7	57
Jibboom	5	8.8	44
Rudder	26	.0	...
Tiller and gear	14	.4	6
Sails	24	4.7	113
Clutch G	8	1.0	8
Braces H and L	50	3.5	175
Iron work	60	5.4	324
	686		2,886
Crew	300	.9	270
	986		3,156
Ballast	27½	1.8	49.5
Total weight	1,013½	Right. mo.	3,205.5

Righting leverage about EF... $\frac{3,205}{1,013\frac{1}{2}} = 3.2$

POSITION 2—MOVABLE BACKBONE IN CENTER

Item.	Weight.	Leverage.	Moments in ft. lbs. about RS.
Backbone	166	5.4	896
Cockpit M, etc.	105	2.5	262
Cross plank	95	5.6	532
Two runners	60	5.6	336
Mast	43	6.7	288

Boom	20	3.9	78
Gaff	10	5.9	59
Jibboom	5	8.5	42
Rudder	26	.0	....
Tiller and gear	14	1.3	18
Sails	24	4.9	118
Clutch G	8	3.2	26
Braces H and L	50	3.9	195
Iron work	60	5.5	330
	686		3,180
Crew	300	2.7	810
	986		3,990
Ballast	27½	5.5	151
Total	1,013½		Right. mo. 4,141

Right. leverage about line RS. $\frac{4,141}{1,013\frac{1}{2}} = 4.08$

POSITION 3—MOVABLE BACKBONE TO WINDWARD

Item.	Weight, lbs.	Leverage about line EF.	Moments in ft. lbs. about CD.
Backbone K	166	5.6	930
Cockpit and bar M	105	4.0	420
Cross plank	95	5.7	541
Two runners	60	5.7	342
Mast	43	6.6	284
Boom	20	4.3	86
Gaff	10	5.9	59
Jibboom	5	8.0	40
Rudder, etc.	26	.0	...
Tiller and gear	14	2.0	28
Sails	24	5.2	125
Clutch G	8	5.3	42
Braces H and L	50	4.3	215
Iron work, etc.	60	5.6	336
	686		3,448

Crew	300	4.5	1,350
	986		4,798
Ballast	27½	8.8	242
Total weight	1,013½		Right. mo. 5,040

Righting leverage about CD... $\frac{5{,}040}{1{,}013\frac{1}{2}} = 5'$

RIGHTING MOMENTS, CALCULATED FOR CONVENTIONAL TYPE OF ICE-BOAT GALE

Item.	Weight.	Lever-age.	Moments in ft. lbs. about AB.
Backbone	288	5.6	1,613
Cross plank	143	7.2	1,030
Two runners	89	7.2	640
Mast	39	8.5	331
Boom, 18 ft. 6 in.	21	4.8	101
Gaff	9	7.3	66
Jibboom	5	11.5	57
Rudder, etc	29	.0	0
Tiller	9½	.7	7
Sails	24	5.9	142
Iron work, etc.	57	7.0	399
Total	713½		4,386
Crew	300	1.6	480
Total weight	1,013½		Right. mo. 4,866

Right. leverage about line AB. $\frac{4{,}866}{1{,}013\frac{1}{2}} = 4.8'$

There are various methods of controlling the movement of the movable backbone or lever arm, one of which is by a friction clutch placed

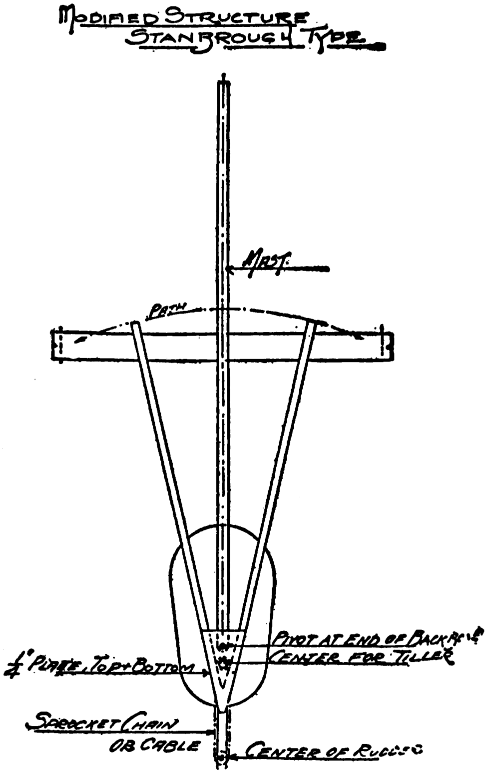


FIG. 4.—Modification of Stanbrough boat, with cockpit carried on two movable lever arms pivoted to rigid backbone, utilizing weight of crew as ballast.

in the forward end of the cockpit handy to the helmsman's hand, whereby the friction of the

lever arm on the guide between the two cross-bars L is increased or lessened at will, so that the movable part may be fixed in any desired position. It can also be worked out with a wire rope, working over a drum in the center of the movable backbone and controlled as in the other case by a clutch or small hand lever.

There is a still further modification of this principle, and a much simpler one, which is shown in Fig. 4, in which the movable portion carrying the rudder is pivoted on the fixed backbone as in the previous example, but instead of having one lever arm extending forward, there are two in the form of the letter "V", meeting and being bolted through the movable rudder support and extending forward to and resting on the cross runner-plank. These two arms carry the cockpit and crew and simplify greatly the details of construction. Where the two arms meet the movable rudder support they are strengthened by a ¼-inch V-shaped iron plate on the top and bottom as shown in the cut, through which work the pivot at the end of backbone and the tiller head. In this case control is very easily worked out by means of a wire rope from each lever arm to the backbone and to a clutch in the cockpit. Fig.

3 shows the new type in profile, and explains the method of pivoting the movable portion upon the rigid keel or backbone.

In placing this boat before the public I have not gone into the minor details of construction, as I am only explaining the principle here. I built one of these boats last year, and have tried her out with very good success.

CHAPTER VIII

Sailing And Racing An Ice-Yacht

BY ARCHIBALD ROGERS

AS ice-yacht racing has generally been between the best and largest yachts of the different clubs, and as during recent years the courses for the same have been accurately surveyed, and as in nearly all cases these races have been sailed over windward and leeward courses and not with beam winds or triangular racing, it is possible to gauge the average speed of ice-yachts under such conditions. We are accustomed to hear exaggerated accounts of the very high speed attained. There is no question in my mind that, given an absolutely smooth surface of ice of sufficient area and extent, and a wind of the proper velocity, an almost unlimited speed might result. I see no reason why under such conditions, an ice-yacht could not be driven at the rate of 100 miles an hour. But sailing on the

Hudson River, whose average width is not over three-quarters of a mile, necessitates keeping a course clear of each bank, which means that much loss of speed occurs, as the yacht is not enabled to hold her course for more than a few minutes at a time.

Another element that knocks down the time in sailing these races is the slowing up for rounding the leeward buoy, and where this has to be done several times it naturally lengthens out the time made in the races. It has been calculated that in sailing a race of 20 miles, in which the buoys are from 2 to 2½ miles apart, and where you have to sail four or five times over the course, the actual distance the boat traverses will be 31.38 miles, instead of 20.

It will therefore be seen that over the Hudson River courses, which, as I have said, are always true courses to windward and leeward, the average rate per mile is about 1 minute and 55 seconds.

Now, of course, with a beam wind, much faster time could be made, for it has been proved that sailing under these conditions over a course one mile long, accurately surveyed, yachts will travel the mile under a minute.

A good many years ago I laid off such a

course, and with several yachts that are very much inferior in speed to those existing to-day, and much smaller in size, sailed repeatedly over a measured mile, when the average speed for at least ten trials was a mile in 59 seconds. I also once, sailed a race with *Jack Frost*, against *Haze* when for 6 miles we attained a speed of 84 miles per hour, but this was with a quartering gale. However, there is no question as to the speed of an ice-yacht, neither is there any doubt that they can and do sail faster than the wind.

The friction of the runners on smooth even ice is comparatively small and hardly need be taken into account. The resistance, though, due to windage at these high velocities from spars, halyards, shrouds and other parts, is no doubt very high. It is probable then that this is nearly the entire resistance the ice-yacht has to contend with, and it is also probable that this resistance is proportional to the driving power.

Many people have asked: "Does not an ice-yacht sail very close to the wind?" Well, yes; she will sail very close to the wind, but under those conditions she is not sailing fast. The closest that an ice-yacht will sail is within 30

degrees or 2 2/3 points, but that is not the best course to sail in order to reach the farthest point to windward. Another yacht sailing very much further off the wind, or say somewhere about five points, would, if they both started together, attain the windward mark almost twice as soon as the one that was sailing so much closer to the wind. In other words, she makes up in speed what she lost in pointing.

As a matter of fact, the yacht sailing about five points from the wind advances to windward at the rate of half the velocity of the wind, while her speed is equal to that of the wind. However, some of these points will be referred to again when a description is given of how to sail an ice-yacht.

Many persons not acquainted with the sport and reading exaggerated accounts of accidents in the papers, have supposed that ice-yachting is a highly dangerous sport. As a matter of fact, I believe it to be singularly free from danger. There have been comparatively few serious accidents; the men who sail have considerable experience, and the yacht being, as a rule, under such marvelous control there is little liability of injury, unless the helmsman is grossly careless or incompetent.

We have had a few legs broken and a few abraded knees from being thrown out on the ice, but beyond this and occasional duckings in very cold water, nothing serious has occurred. It is worthy of note that bystanders and people skating on the ice are being educated up to the point that the safest thing for them to do when they see an ice-yacht approaching is to remain perfectly still, in order to give the helmsman an opportunity to decide what course to steer.

Advice is cheap, they say, but I can well remember a certain ten minutes in a large ice-yacht during which I had advice of the strongest kind and in the most emphatic language from the late Jacob Buckhout. I think that I learned more during those ten minutes than I had in years of sailing. Advice, of course, must be of the right kind, and it should come from a professor in the art.

Many men I have known can sail an ice-yacht passably well. Some of them are excellent helmsmen when it comes to a racing or cruising yacht on water, but somehow or other they do not seem to get the knack of sailing an ice-yacht properly. Now, why should it be difficult to learn to sail the latter if you understand sailing the former? Well, the difficulty

lies in this fact, that the whole secret consists in sailing her to leeward. Anybody at all conversant with helmsmanship as applied to water sailing, can get on an ice-yacht for the first time and sail her to windward.

A hearty laugh has arisen from teasing some novice into taking out a small ice-yacht. We say the wind is not too strong, and that it is from the north, and he is told to get aboard and sail up the river for a mile or so and then turn around and come back. We tell him, with absolute truth, that he will have no difficulty in sailing. We remark casually that perhaps he won't come back so very fast, but he will get up there all right; and true enough he will. He will have no difficulty at all in going up to windward, and this naturally gives him confidence, and he says to himself: "This is very easy; anybody can sail an ice-yacht."

He reaches the place where he should turn around and come back to receive the congratulations of his friends, who are awaiting with much pleasure his return. Up goes his helm, and immediately the boat he thought was so easy to sail, starts off at a terrific rate of speed, and he begins to lose a little confidence. His first impulse is to stop, especially as he sees him-

self rapidly approaching the opposite shore. He luffs up into the wind, but as she does not stop, he goes on the other tack. He gets out into the middle of the river and says, "I will just turn and come back," so he pays her off again, when the same performance recurs. She immediately develops a high rate of speed; he is running toward the other shore much too fast for pleasure, and now he says to himself: "I will just sail her easy and then try to throw her right off."

So by this time, having gone far beyond the point at which he desired to turn around, he starts very slowly. We will say he succeeds in getting his yacht before the wind, but the chances are the action was so sudden that she has not only gone off before the wind, but she has come right around back on the wind again with a very strong probability that the unfortunate tyro has parted company with his craft. Let us assume that he has done so and that he regains his charge with perhaps a somewhat diminished confidence in his own powers of sailing. Things don't look quite so easy as they did. He begins to think: "Well, I will try this again, but one thing is sure, and that is, I must stay aboard." So, starting again after

several unsuccessful attempts to wear off before the wind (during which he is perhaps now double the distance from home), he does succeed in getting his boat directly before the wind, but he finds that she hardly moves. He sees other yachts with laughing occupants sailing in circles all around him, traveling at a high rate of speed off the wind and on the wind, and he endeavors to imitate their example.

One minute he is tearing along 40 miles an hour, and the next minute is not sailing at all, until finally we see him strip off his coat, get down to his shirt sleeves, and with perspiration rolling down his face, ignominiously push his yacht toward home, where he knows he is almost sure to meet his jeering and smiling friends.

This is not an exaggerated picture at all. It has happened repeatedly, and that is why, although almost any one can sail to windward, sailing before the wind requires a special education. Let us see if I can make this plain. In the first place an ice-yacht always has her sails trimmed flat, very flat, under the conditions of an average moderate breeze blowing up or down the course desired to be sailed over. I am not speaking of gales of wind. What I

mean is a wind of such strength as lends itself to sailing for pleasure. Heavy beam winds or westerly gales will be mentioned later on.

The trend of the Hudson River (where most of our sailing is done) is practically north and south, and therefore northerly or southerly breezes are the best, since they give true windward and leeward work. Now, it may be asked, why the sails should be trimmed so close, or why, in going free, the mainsail should not be slacked off, as is the case in water sailing.

Without going into a mathematical demonstration I will explain why. It can be easily understood that if when running before the wind, the mainsail were slacked off at right angles to the direction of the wind, the speed of the yacht to leeward would not be greater than the wind. But we do know that an ice-yacht can travel faster than the wind, and we do know that in order to reach a given point to leeward as quickly as possible the angle of the boat and the angle of her sails with the wind must be 150 degrees, or, in other words, about thirteen points from the wind; and that under these conditions the advance to leeward would be one and one-half times that of the wind itself. Therefore, it is plain that to make

that angle good the sails must be trimmed flat aboard.

GETTING UNDER WAY

Perhaps a description of actual sailing may make things clear. We will start to windward—and let me say here that boats seldom carry more than two persons, the helmsman and one man for a crew, or a friend as a passenger. The common custom is for the helmsman to sit on the left side of the cockpit, so that his right hand is free to use the tiller and the left to grasp a rail or some other convenient point on the cockpit. We will assume that the helmsman is alone. We will also assume that this is a jib and mainsail yacht of moderate size, that the wind is north, and that he is going to sail a few miles up the river to windward and return back to the point from which he started.

In approaching his yacht from the port side he should find the point of the tiller reaching out transversely across the stern. Taking hold of the tiller in his right hand, he moves it amidships. Then he trims his sails; it is understood that the boat is lying head to wind. The mainsail being trimmed down to the proper limit,

he reaches for the jib sheet, which leads to a convenient point at the forward end of the cockpit. This is trimmed in and belayed on its cleat. The yacht is now ready to start and the probability is that, having been in one position for perhaps fifteen or twenty minutes, her runners have imbedded themselves in the ice.

It will be necessary then to exert some little force to "get her out of her tracks," as we say. This is done either by some person on the ice starting her ahead by shoving against the rigging, or by altering the position of the helm and prying on the end of the main-boom. She is twisted around so that she catches the wind slightly on the port or starboard side; then straightening the tiller again, a very slight push on the part of the helmsman is all that is necessary to start the yacht.

WINDWARD SAILING

Keeping the right hand on the tiller and the left on the rail of the cockpit, and running alongside till the yacht attains sufficient momentum, the helmsman jumps in and immediately fills off on the desired tack.. Now keeping the yacht a good full, he finds that he can main-

tain an even rate of speed. Again, without a mathematical demonstration, he should sail her about five points off the wind. Should he be approaching poor or rough ice and it is desirable to move more slowly, it is only necessary to luff or bring the yacht closer to the wind, when speed will immediately decrease and she can be moved at any wished-for rate of speed.

There is little to be said on this point of sailing, for all the helmsman has to do is to keep his yacht moving, and if he keeps her further off from the wind than five points he will be tearing along at a high rate of speed but will not be getting to windward as he would if he were sailing at the proper angle. If he keeps her closer than five points he will be sailing much more slowly.

Now he has reached his limits to the northward and wishes to return. We will say that he has a buoy there to round, and is approaching it in such a manner that he must round it from east to west, which necessitates his leaving it on the port hand. He will therefore come for it on the starboard tack and will, if he is racing, endeavor to approach the buoy in such a way that his speed will not be very

great just at the point of rounding and wearing away. The reason for this is, should he endeavor to wear away when at a very high rate of speed it is probable that he would then be traveling with more or less of a beam wind and the yacht might not respond to the helm. In other words, she would either travel faster and luff up, or the pressure would be so great that the windward runner would be lifted high in the air and the yacht refuse to wear off.

LEEWARD SAILING

Now, there is a point well worthy of note, and drawn from experience, which is, to catch just the right time in wearing off, and if the speed is moderate and the yacht reasonably well balanced there should be no difficulty in getting off before the wind, and that, too, without undue strain or discomfort. We will take for granted that the speed having been properly diminished, the yacht is put off before the wind gently and easily, and then she assumes the position immediately after rounding the buoy of what would correspond to a sailing vessel's starboard jibe, only that instead of the main sheet being slacked off the mainsail and jib are

both flat aboard. In thus wearing off, the yacht receives increased momentum, and the helmsman, instead of immediately heading due south (the direction in which he wishes to go), should allow this momentum to increase to what he considers its maximum point. He knows, or has been told, that in sailing free the most rapid progress to leeward would be somewhere about thirteen points off the wind, and he endeavors to accommodate the position of the yacht to that angle. Assuming that the buoy which he turned was in the middle of the river, it necessarily follows that after he has rounded and gone off on the starboard jibe he will be heading somewhere about southwest, and in a moment or two he will approach the western shore of the river.

Now he wants to go down the river, or to travel south; he does not wish to return and go north. Of course he could luff up and go off on the port tack and then go free again on the port jibe, but this is not what he does. The proper thing (as soon as the yacht has approached near enough to the shore) is to put the helm up gently, and with a long, easy sweep the direction is changed gradually from the course he has been sailing around by south to a

southeasterly course. If properly carried out the act of jibing will hardly be felt. When the boat is traveling on her own course, should the helmsman notice a decrease of speed, he must luff and continue to luff until she is traveling at what he thinks is her maximum speed, and then, and then only, is he to keep away, when he will find that the yacht is still going at a high rate of speed. In fact, the yacht can often be run on a course nearly south from either jibe when sufficient momentum has been attained in the manner indicated, but the instant it is felt speed is being sensibly decreased, he should turn back toward the wind. It is immaterial on which jibe this is done.

Small yachts (and large ones, too, for that matter), dead before the wind, running at a very high speed, are often difficult to steer, especially if the surface of the ice is at all uneven. This is owing to two things: (1) the tendency of the boat to "pitch pole," (2) the rolling motion which is set up in the cockpit. In the former case the rudder is lifted, in the latter it is jerked sideways. In trying to counteract these successive impulses it frequently results that the yacht suddenly whirls around. Should this occur hold on, and hold on hard.

Many a race has been lost by this mishap, or a refusal to wear off and run free.

Sometimes it is absolutely necessary when running to reverse suddenly or stop. For instance, I was once driving off before the wind at a very high rate of speed, with one of my large yachts, the *Blitzen*. I supposed I had good ice before me and a clear course. The wind was blowing fresh from the north, and the yacht was sailing south, or down the river. Glancing up I discovered to my dismay open water directly ahead. I saw this was not a crack that could be jumped, but just good plain old Hudson River.

There was no time to dodge it at the speed *Blitzen* was making. I knew it was stop or swim. The latter might be necessary in either case, but I gave it the benefit of the doubt and put my helm down, as I thought I had a trifle more room that way. At the same instant I threw my right leg over the tiller to assist in holding it in place. Gripping the hand rail hard with my left hand, I think, nay, I am sure, I shut both eyes. I heard a great crunching and grinding, and felt the cushions slide out from under me. I appreciated the fact that some mighty force was at work trying to stand

me on my head and tear me out of the cockpit, and that this took place twice. I then concluded it was time to open up and look about to see what the damage was, and none too soon either. The yacht had gone around with tremendous velocity twice in a circle almost in her own length. She then stopped head to wind and immediately began to slip rapidly, stern first, toward the open water. A slight change of the helm (throwing the stern up to windward), the sails filled and a proper distance was quickly gained from the hole.

Some spectators near the shore who were watching my erratic gyrations said afterwards that it was rather a pretty sight; the flying yacht dimly seen through a mist of sparkling crystals which were torn from the ice by the grinding runners, and the crimson cushions flying high in the air. They unfeelingly remarked that it only needed an aerial flight on the skipper's part to have made the scene complete. It speaks well for rigging and construction that everything held, and the only things which parted were the straps holding down the cushions in the cockpit.

However, to return to the sailing, the yacht is now, we will suppose, going nicely to lee-

ward and approaching the buoy or mark to be turned before coming back on the wind. This is the time to do a little ciphering and to maneuver so as to get the yacht on the right jibe (the buoy is to be turned from east to west, and therefore must be left on the starboard hand), and to deaden her way, so that in rounding she will come up easily and not slide off to leeward and strain things, as would certainly be the case if great speed were maintained right up to the mark. In racing, of course, if one is behind in this leeward sailing, the yacht must be driven right up to the limit and trust to luck to get around safely, but care must be taken that she does not get out of control or whirl around into the mark. Another thing must be borne in mind, and that is, too sudden a turn very often results in the boat shooting up into the wind and stopping.

Suppose now, instead of rounding marks, etc., one is out sailing for pleasure, on a little visit to a neighboring boathouse, where some ice-yacht chat can be indulged in. First we will run up to windward to such a place and stop; then, when all the gossip has been heard, we will run back to leeward to our home anchorage. Starting as before, we beat up at a

speed to suit, perhaps having a friendly brush or two with some ambitious craft on the way. Let us suppose that the place we are approaching, and where a stop is to be made, is one of the club stations, and that a dozen ice-yachts are anchored on the river off the clubhouse, and also that another lot are sailing about in close proximity. To still further bring out a very prevalent state of affairs, add a number of people of all ages skating or standing about watching the pretty scene.

STOPPING

You will say this no place for a novice to come tearing up to on an ice-yacht traveling thirty miles an hour or more. No, it is not, and so long as he remains a novice it will be well for him to stop a good distance off, before this confusing crowd of people and boats is encountered. But how is he going to stop? It is very easy, but not always to be learned at the first trial or two; so if he finds he cannot stop and is getting nervous at his close approach, at least he can go on sailing, and this he should do until he reaches a point beyond and above all the people and boats.

Then he may try to bring the yacht to rest. But as a matter of fact all that it would have been necessary for our novice to do was to place his helm amidships and steer the boat up into the wind's eye and hold her head to wind until all momentum had ceased. Then he should get out on the ice, loosen the jib sheet, draw the tiller back until it is at right angles to the wind, or the fore and aft line of the center-timber, when the rudder will be what is called across the yacht, and prevent its moving forward or backward.

Should the wind be squally and frequently shifting several points, it will be wise to lower the jib and slack off the main sheet a bit, so that if by reason of shifts of wind the mainsail fills, the stern of the yacht simply swings on a circle until the mainsail shakes, and it will keep this up indefinitely. Should, however, the jib have been left hoisted, even if the sheet were free, its slanting about is very liable to cause it to foul, and then if a hard puff were to fill the sails the yacht is pretty sure to move ahead, when the rudder tails out behind, and a runaway and perhaps a wreck is the result.

So much for the novice. He is not to take any chances, and he must bring to before he

reaches a crowded anchorage or go by until he is quite alone. Let us suppose he has gone well up to windward before he has managed to stop, and that he has gone so far that it seems a hardship to walk or drift back. Of course if the place where he had brought up was dead to windward, the breeze true and strong and he has a very cautious disposition, all that would be necessary for him to do would be to put the tiller amidships and let the yacht drift stern first before the wind, then, when he wished to stop her, he must jump out quickly and jerk the tiller directly across, holding it there. This would bring the sharp shoe of the rudder in opposition to the line of motion, and by its grinding over the ice would act as a brake, bringing the yacht to rest. It is not very neat, requires some practice, and if repeated frequently would dull the fine cutting V edge of the rudder.

One can stop in this way, too, in going to windward, provided the yacht is head to wind and traveling at a low rate of speed; but the writer does not recommend this method and seldom uses it, neither does he see many good helmsmen grinding off and dulling their rudders.

Now our novice is not going to drift back, but having summoned up his courage, and remembering all that he was told about approaching an anchorage to leeward, he determines to sail back and get somewhere near the point he wishes to reach. He therefore gets way on the yacht, and wearing off on either jibe, runs down at a moderate rate of speed well to leeward of everything and everybody. Having more confidence he rounds to and stops head to wind, when if he finds he is still too far away a few short tacks taken slowly will enable him to get up as close as he pleases to the desired point, and here he will, if he is wise, stop his yacht to leeward of everything.

So much for the elementary. What will the skilled ice-yachtsman do? Nothing very different, except in degree. He will have more dash and confidence, and perhaps like to show off a trifle and let people see what control he has over the graceful machine he is guiding so skillfully. If he is beating up to a crowded anchorage he lets his yacht travel right along and picks out just the one little spot where he means to finally anchor, or place himself. Perhaps it is right in amongst all the others, and there is just room for him to squeeze in. To the onlooker it seems silly and dangerous, but

our helmsman is keeping a bright lookout, and knows to a hair what he can do. Luffing up at the right time, he shoots up to the desired place with his yacht almost at a standstill; then, keeping his tiller amidships (that is in a fore and aft line), and resting his right knee on the side of the cockpit, he digs his sharply spiked left heel into the ice, and holding back hard with the left hand brings the yacht to rest. But perhaps with all his skill he has overdone things, and finds he has more way on than he supposed. Perhaps another boat is just getting under way, or the ubiquitous small boy and sled shoot out across his path. Here the advantage I have described as to the helmsman's position becomes apparent. He is ready for instant action. His hand is grasping the tiller, his body is practically in the cockpit, and all that he has to do is to pull up his left leg and follow out that good old precept: "Act as judgment says is proper, port or starboard, back or stop her." An old hand under these circumstances will simply throw off on either tack, depending upon the room he has, and, wearing off, bring his yacht right around, describing a complete circle. This operation he repeats if necessary.

Having now given a few hints about sailing

in moderate, steady winds, taking for granted the beginner has learned plain sailing and has confidence in himself and his boat, let us examine a rather familiar condition of winter sailing. To make this clear a brief description of the ice surface becomes important, for alas! one does not always have ideal ice to sail over, or, having it, is there always wind. The Hudson in a freezing mood is capricious, and often in early winter will present us with four or five miles of beautiful ice, perfectly smooth and even, and then, owing perhaps to a slight bend in its course, or to the drifting down of some broken-up ice fields which have become jammed and frozen fast, we may be cut off for a mile or more by execrable ice, the surface of which is a mass of jagged hummocks, some of them several feet in height and running either in ridges from shore to shore, or scattered about in great uneven masses, or both. Interspersed amidst all these Arctic conditions will be found patches and lanes of more or less smooth ice. Now, no ice-yachtsman worthy of the name ever hesitates at trouble or work if sailing is to be had anywhere near him. He sees with envy his friends above or below him having the time of their lives (and a good day's ice-yachting

is always the time of one's life). So up go the sails on "old trusty," and a try is made to sail over the intervening rough ice. It takes sometimes a lot of time, skill and patience, with a frequent use of a sharp steel chisel bar to cut a passage through some of the ridges. If these are too wide and too rough the boat is shoved by hand, or if the ice is strong enough very often a pair of horses and a tow rope are requisitioned, until all obstacles are surmounted.

If cracks have to be passed (cracks come from the rise and fall of the tide, or from the expansion of the ice) two timbers must be laid in position, spanning the opening, and then the boat shoved over. Here it may be asked: "Why does not the stern drop in after the runners have passed over on the firm ice?" Because there is a triangular or wedge-shaped contrivance just ahead of the forward point of the rudder. This is called a jumper. It acts as an inclined plane, its bottom striking the edge of the crack before the rudder, and as the yacht moves forward the jumper raises it aft, and so prevents the rudder from catching or running its nose under the ice. It is also a good thing for rough ice, often preventing the tiller from being wrenched out of one's hands.

No ice-yacht should ever sail without being equipped with one of these jumpers.

Having constructed a passage through the rough ice fields, and having enjoyed the reward of a grand day's sailing, it becomes necessary to return to our home anchorage. Right here is where a novice would come to grief, probably wrecking his yacht at the first barrier, and picking his bruised body out of the debris, would conclude he had something still to learn. It takes a good hand at the tiller to navigate under these conditions, stopping, twisting, turning, now on one side of the river and now on the other, often sailing backwards to make a fresh start or to get one's yacht in the right position for passing through a place that is just wide enough to clear the runners; not to get going too fast, or if that occurs, as it often does, to be able to reduce speed and dodge about on a surface of only a few hundred square feet. All this is pretty trying, even to an old hand; and he gets caught sometimes at a high rate of speed, where the only thing he can do is to hold up and charge the obstruction as squarely as possible. It is astonishing over what apparently hopeless places these ice-yachts will sail, forcing a way, knocking aside and smash-

ing up huge blocks of ice in the performance.

SAILING IN HEAVY WEATHER

Westerly gales are, however, the most trying to an ice-yachtsman's temper, and the sailor requires much skill in keeping his yacht moving in a straight course. The high and mountainous character of the Hudson on its west bank breaks up a fresh westerly wind into a succession of calms and very strong puffs, the latter often circular in their action, varying five or six points. At one instant the yacht is tearing along at a really terrific speed under too much canvas, and at the next a flat calm prevails. Here one must first try to reef down to what is right for the average strength of the wind, and next to adjust the sheets by slacking them sufficiently, so as to sail through the squalls and keep moving all the time. Very often the calm streaks may be sailed through and the yacht be carried along from puff to puff.

It is impossible at times to prevent a sudden sharp luff into the wind during squalls, when a yacht is liable to rear up; that is, the windward runner is lifted high into the air and the yacht runs along frequently without minding her rud-

der. Some yachts, though, when nicely balanced (even though they are reared up), can be steered under these conditions, and when the trick is learned, one can raise and lower the windward runner at will, dropping it down so gently that no jar at all is felt. Others again come down very often with sufficient force to break the runner-plank in two.

It may be asked: "Why do not the yachts upset or blow over when their windward runners are high in the air, almost at right angles to the ice?" They do sometimes; but if a yacht has good way on it goes over so far, and then the end of the main boom bears on the ice and prevents its capsizing. But should the yacht slow up by reason of running into either shell ice or soft spots, the chances are that over she goes until the end of the mast strikes the ice. However, she is easily righted and if nothing has been broken is soon sailing again as if nothing had happened, and the crew have no wet jackets to think about.

I am often asked about cracks and how to get over them. If the crack is pretty wide and in a place where there is no room to maneuver, place two timbers spanning the crack and spaced apart a distance of about four feet less than the

extreme width of the runner-plank. But where the ice is smooth and not rotten quite a wide distance may be crossed under the yacht's own momentum and without timbers being placed in position, provided sufficient speed can be attained just before reaching the crack. Then the yacht should be held, if going to windward, head to wind, or if running free, dead before just when the crack is reached. This is to keep the runners and runner-plank in a perfectly horizontal position, so that when the jump is made the runners will hit the far side fair and square, when they will glide up on to the firm ice and not catch or run under. If one should try to jump a crack diagonally the pressure on whichever happened to be the lee runner would, as soon as it left firm ice, cause it to dip down, and there being no support the yacht would slew around and capsize, with half of her runner-plank submerged and the other half pointing to heaven, and with perhaps her sails in the water if the crack were a wide one. Anyway, things are generally in a mess, and as the sails must be lowered and all the work done in icy cold water with perhaps ice that keeps breaking off at the edges of the crack, it is no joke.

The clearing of a distance of 21 feet, 6 inches by an ice-yacht is the widest I know of. This I did in *Jack Frost.* The measurement was taken with a steel tape from the point where the runners left the ice to where they first landed.

≈ 83 miles/hr. if he dropped ≈ 6'' from one side to the other.

CHAPTER IX

The Speed of Ice Boats

By Archibald Rogers, with an explanation by Nathaniel G. Herreshoff.

SO much has been written, and so many misleading statements have been made, about the speed of ice-yachts that it is worth while to consider just what has been actually done in this line and of what the boats are really capable. That very high rates of speed are frequently obtained is certain, and that on certain points of sailing ice boats can, and do, go faster than the wind that drives them, is not only true but is a demonstrable fact.

Absolutely reliable data beyond the championship races are few and far between, for it is seldom that a course over which other races take place is accurately measured. The distances for the pennant contests are known by marks on the shore which have been placed there permanently by surveys, and in placing the buoys or turning-marks on the ice the great-

est pains are taken to have them accurately established. In order to examine this matter of speed, I have made a table of the races for the Challenge Pennant, showing all the particulars, especially the distances between the marks, and therefore the lengths of the courses sailed, and I believe these distances to be substantially as stated. The course on February 5, 1892, was surveyed, and also measured by a registering wheel. I have also plotted on paper the approximate distances an ice-yacht would actually sail in covering the various courses. These results are tabulated on the sailing card. In working this out the river was laid off as half a mile wide, which is about the average width where the races take place, and as most of these were sailed with a wind blowing or drawing nearly straight up or down the course, which also is always up and down the river, the calculated distances sailed should not deviate to any great extent from the real distances. At any rate the plan adopted has seemed to the writer the best way of arriving at anything like the truth.

It will be seen by inspection of the table that the fastest time made in any of the races for the pennant was that of *Jack Frost,* February 9,

1893. The twenty-mile course was sailed in 0 h. 49 m. 30 s., or at the rate of a mile in 02 m. 28 s. for that distance, but the calculated distance the yacht sailed was 31.38 miles, and this means a mile in 01 m. 34 s. The slowest race occurred January 21, 1899, when it took *Icicle*, 1h. 09 m. 37 s. to sail the twenty-mile course. This, it will be seen, is at the rate of a mile in 03 m. 29 s., but in reality 02 m. 13 s., as the calculated distance sailed was 31.38 miles.*

The average rate of speed for these races is 01 m. 55 s. per calculated mile; and, as I believe a yacht in actual practice will sail over rather than under the calculated distances, it is safe to assume that the speed of an ice-yacht with a strong, steady breeze, over a true course to windward and return, is faster than this rate of a mile in 01 m. 55 s. The narrowness of the river forces the boat to tack or alter its course frequently when sailing either to windward or off the wind, which not only increases the time, but also the distance over a given course.

* The *Wolverine*, of the Kalamazoo I. Y. Club, has to her credit a record in a race to windward and return of 20 miles in 40 m. flat, or at the rate of a mile in 2 m. Distance actually sailed not known.—[EDITOR.]

Name of Winning Yacht	Club.	Date.	Distance between Buoys in Miles.	Number of Times Sailed Over.	Total Length of Course in Miles.	Calculated Distance Sailed in Miles.	Time.	Apparent Rate per Mile.	Calculated Actual Rate per M.
							h. m. s.	m. s.	m. s.
Phantom	New Hamburg vs. Poughkeepsie	March 5, 1881	....	......	20	.....	0 57 14	02 51	....
Avalanche, or Robert Scott.	Poughkeepsie vs. New Hamburg	February 6, 1883	10	Once	20	31.38	0 57	02 51	01 49
Jack Frost.....	Poughkeepsie vs. North Shrewsbury	February 23, 1883	2½	Five	25	39.20	1 14 35	02 59	01 54
Haze	Poughkeepsie vs. North Shrewsbury	February 9, 1884	6 66-100	Three	20	31.38	1 05 30	03 16	02 05
Haze	Poughkeepsie vs. New Hamburg	February 14, 1885	2	Five	20	31.38	1 01 15	03 03	01 57
Northern Light	Poughkeepsie vs. North Shrewsbury	February 18, 1885	2½	Four	20	31.38	1 08 42	03 26	02 11
Jack Frost.....	Hudson River vs. Poughkeepsie	February 14, 1887	2	Four	16	25.10	0 43 40	02 43	01 40
Icicle	Hudson River vs. North Shrewsbury	March 8, 1888	2	Three	12	18.83	0 36 59	03 04	01 57
Icicle	Hudson River vs. North Shrewsbury	February 25, 1889	2	Four	16	25.10	0 51 41	03 13	02 03
Icicle	Hudson River vs. North Shrewsbury	February 5, 1892	1 46-100	Five	14 6-10	22.92	0 46 19	03 09	02 01
Jack Frost.....	Hudson River vs. Orange Lake	February 9, 1893	2	Five	20	31.38	0 49 30	02 28	01 34
Icicle	Hudson River vs. Carthage	January 21, 1899			20	31.38	1 09 37	03 29	02 13
Jack Frost.....	Hudson River vs. North Shrewsbury	February 7, 1902			20	31.38	1 02 21	03 07	01 59
Jack Frost.....	Hudson River vs. North Shrewsbury	February 13, 1902			20	31.38	0 53 24	02 40	01 42

One point must always be borne in mind, and that is, that an ice-yacht invariably sails close-hauled, that is, with her sails trimmed flat in, whether in beating to windward or driving off before the wind. This is easy to comprehend when going to windward, for here a boat on ice sails the same as one in the water, but off the wind or sailing free it is another matter. It can be readily understood that in this case if sheets were started and sails were allowed to go off, so as to be at or nearly a right angle to the wind, the yacht would not advance to leeward quite as fast as the wind, as some force must be expended in overcoming friction; hence it is that in sailing before the wind the sails are trimmed close aboard, so that the course of the yacht to reach a given leeward point the fastest would be 150° or 13 1-3 points from the wind, when the advance to leeward would be one and a half times that of the wind itself. be one and a half times that of the actual wind itself.

The explanation of this curious feature of ice-boat sailing cannot better be described than in the paper Mr. N. G. Herreshoff, of Bristol, R. I., has so kindly written for me. Mr. Herreshoff's well-known ability as an engineer and his fondness for mathematical problems must

lend great interest to it. It will be found here in his own words.

Extraordinary rates of speed for short distances are constantly occurring, but, as I have stated before, they are not over surveyed courses. The writer, though, to test the question, laid off a measured mile on the ice, and when the conditions of wind were favorable, tried a number of small yachts over it. The best record was 59 s. Estimated speeds, that is, sailing up or down the river between known landmarks, have given still higher rates of velocity; in one instance a passage was made by two yachts racing on a reach where the time made was believed to be at the rate of eighty-four miles per hour. That this very great speed is probable or possible, is not to be doubted, but it occurs very seldom on the Hudson, as the danger of colliding with the rocky shores makes each helmsman keep his slippery charge under control.

MR. NATHANIEL G. HERRESHOFF'S EXPLANATION OF HIGH SPEED POSSIBLE IN AN ICE-BOAT

The resistance of water to a sailing boat, although very small at a slow rate of speed, in-

creases enormously as the speed increases, and entirely prohibits a very high speed in any sailing vessel. For she must have weight in order to give her sufficient stability to carry her sail, and considerable immersed surface properly placed, to prevent her from making leeway. The result is that the displacement of so much water by her great weight generates a series of deep waves, which absorb an enormous amount of power. And as the frictional resistance of a fluid increases as the square of the velocity, the amount of power absorbed in the surface friction also becomes large at high speeds. These absolutely check a very high rate of speed being obtained.

Under very different conditions the ice-boat glides along over the smooth, even surface of our frozen lakes and rivers.

The resistance of the runners in a good ice-boat is very small indeed. And, moreover, it does not increase sensibly with an increase of speed.

In making a rough estimate of the possible speed of an ice-boat, the resistance of the ice may be neglected altogether. And then the ice has only one office to perform, but a very important one—that of guiding the boat in the

way it is desired to go. For this the runners have to be formed so that they will cut into the ice a very little, and the groove thus formed makes a wall of ice of sufficient obliquity to prevent the runners from going sideways by the pressure of the wind on the sail.

The wind resistance, or "windage," as ordinarily expressed, is then nearly the entire resistance the ice-boat has, and it prevents her from attaining an almost incredible speed. The windage of an ice-boat is a comparatively easy thing to deal with, since it is of the same nature as the driving power, and under the same conditions of boat and its sail will always be proportional to the driving power.

To explain the principle on which an ice-boat is moved by the wind, we will first suppose she has no windage, and no resistance of any kind to progress in direction of the runners. The sail is set at an angle with the runners, so that the one side of the sail on which the wind presses and the opposite side of the runners form a wedge, one side of which is pressed on by the wind, and the other by the ice against the side of the runner, as shown in Fig. 1.

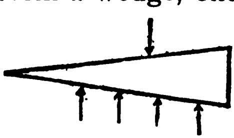


FIG. 1.

The side of the runner against the ice effectually prevents the boat from going sideways, but she is not prevented from going endways. The wind has no power on the sail other than in a direction perpendicular to the sail's surface; but this direction is not perpendicular to the direction of the runners, and it is easily seen has a tendency to press the boat ahead as well as sideways, and since the sides of the runners resist side motion, it goes in the direction in which there is no resistance.

Without going into the science of the resolution of forces and motions, I think it will be quite evident to any one that if the surfaces of our wedge have no friction to hold it in place, and if it is pressed on near its butt, it will move away from the pressure its full length, while the pressing medium is moving the thickness of its butt. And, moreover, if we suppose the butt of the wedge always cut off in direction of movement of the pressing medium, the distance across the butt in that direction will be the amount of movement of the pressing medium in the time the wedge is moving the length of its base, (see Fig. 2). And the larger the base of the wedge in

FIG. 2.

proportion to the distance across the butt, the greater will be the velocity of motion of the wedge.

If we consider now the pressing medium to be a particle of air in motion, the direction of which is the direction of the butt of the wedge, and the rate of motion in a given time the breadth of the butt, the runners to be the base of the wedge and the sails the inclined surface of the wedge; then will the length of the base of the wedge be the rate of motion of the ice-boat in the given time, and to any one on the ice-boat, the particle of air (if it could be seen) would seem to slide along the surface of the sail as the boat advanced, and to him has a motion in direction of the sail's surface, or of the inclined side of our wedge. This we will call the apparent direction of the wind. To the person on the ice-boat the particle of air will appear to move at quite a different rate from its real motion, and this motion (which we will call the apparent velocity of the wind) will be the length of the inclined surface of the wedge.

I think it will be easily seen that, if the angle of the sail with the runners is sufficiently small, the speed of the boat will be much greater than

that of the wind, providing the direction of the wind is not too near parallel to the runners of the ice-boat. When the sail is set at an acute angle with the runners (as is always the case), and, as I have shown, the apparent direction of the wind is nearly that of the sail, its pressure on the hull and rigging of the boat—in fact on every part, excepting the sail itself—is an opposing force of more or less magnitude, increasing when the angle of the sail with the runners decreases. Actually the apparent direction of the wind is not the same angle with the runners as the sail is, but a little greater angle, and for a given angle of sail would always be greater by the same angle, whether the wind velocity be great or small, providing the ice resistance is so small as to be neglected.

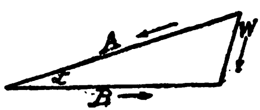


Fig. 3.

Now, referring again to our wedge, if we substitute the apparent direction of the wind in place of the sail, on the inclined side, we have a triangle formed by the three sides of the wedge (see Fig 3), in which we will suppose we know the angle, and which is the apparent direction of the wind with the runners of the boat, and the side *W*, which represents the

velocity of the wind, and the direction of the side *W*, the direction of the wind. If the course of the boat is also supposed to be known, which is represented by the side *B*, we have sufficient data, by trigonometry, to determine the length of the sides *B* and *A*, which would represent the velocity of the boat, and also the apparent velocity of the wind.

By a simple geometrical construction the "Ice-Boat Problem" can be very easily solved, when the ice resistance is neglected, as shown in Fig 4.

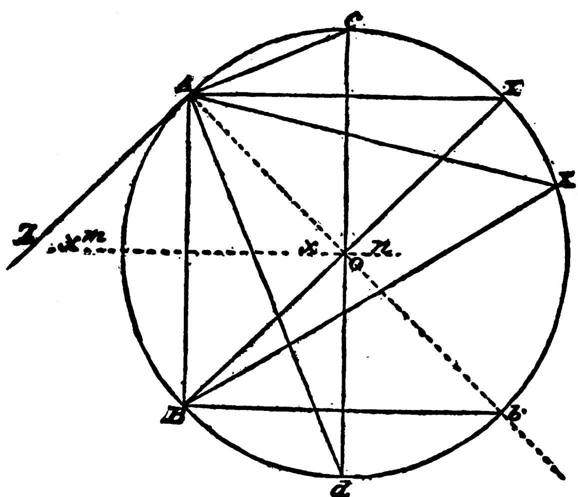


FIG. 4.

Draw the line *AB*, representing by its direction the direction of the wind, and by its length the velocity of the wind. From *A* draw *AZ*, making the angle *BAZ* equal to the apparent angle of the wind with the runners of the ice-boat. Draw *Ab* perpendicular to *AZ*. Draw *mn* perpendicular to *AB*, bisecting *AB*. At the intersection of *Ab* and *mn* to *o* as a center draw a circle cutting *A* and *B*. From *A* draw a line in the direction of the course desired for the ice-boat until it intersects the circle at *X*. Then *AX* will represent the velocity of the ice-boat on that course, and *XB* the apparent direction and velocity of the wind. The angle *AXB* is equal to the angle *BAZ*. For by construction the angle *Aom* is equal to *BAZ*, since *AO* is made perpendicular to *AZ* and *om* is made perpendicular to *AB*. Then *AXB* is equal to *Aom*, for the arc *Am* is half the arc *AB*. *Am* measures the angle *Aom*, and it also measures the angle *AXB*, which is proved in the theorem in geometry. "The inscribed angle in a circle has for its measure the half of the arc of the circle comprehended between its sides."

To know what course an ice-boat should go to attain the highest speed, draw *AX*, repre-

senting the course of boat, so that it will be a diameter to the circle, as *Ab*. Then *bB* will be the apparent direction of the wind, and it varies from the true direction by just a right angle, or 90°.

Draw a diameter to the circle which will be parallel to the direction of the wind, as *cd*. Then the course *Ac* will be that which the boat should take to get to the windward the fastest, and the course *Ad* that which she should take to get to leeward fastest.

It will be noticed that a boat can sail to leeward faster than the wind itself, the veloctiy directly to leeward being the velocity of the wind plus the velocity directly to windward, and that also the greatest obtainable velocity (on course *Ab*) is equal to the velocity to windward plus the velocity to leeward.

If the resistance of the ice were considered, it would complicate the problem somewhat. The angle *a* would be increased somewhat, and would become variable, depending on the pressure of the apparent wind, and in the diagram the curve which bounds the possible limit of velocity of the boat in different courses would not be a circle cutting *B* as well as *A*, but would only differ from the circle as drawn by a small

amount in the parts that would be useful to refer to.

The probable angle *a* in a good ice-boat, and with ice in prime condition, is about 30°. Constructing the diagram upon this angle, $a = 30°$, we have Fig 5.

Thus it is shown that the closest the boat will go to the wind is 30° or 2 2/3 points. That the best course, or the one that will take the

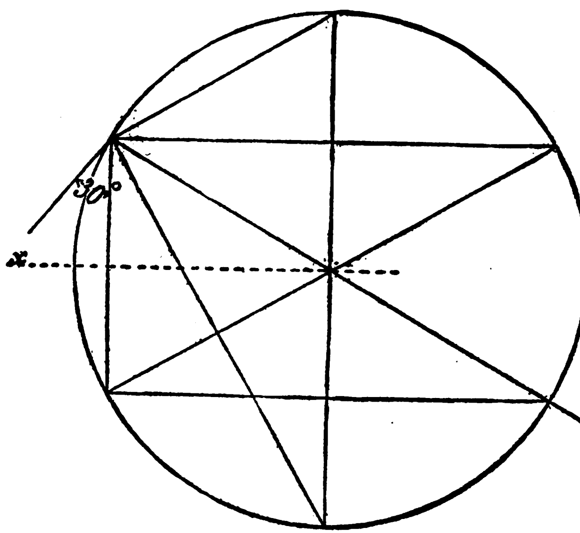


FIG. 5.

boat farthest to windward, is 60°, or 5 1/3 points from the wind, when the advance to windward would be at the rate of half the velocity of the wind, while the actual velocity is equal to that of the wind. The boat encounters the greatest apparent velocity of the wind, when her course is 90° or 8 points from the wind, when the apparent wind is twice the actual velocity. The greatest speed of boat is attained when 120° or 10 2/3 points from the wind, when her speed is twice that of the wind, and the apparent direction of wind is 90° or 8 points from its true direction. The most rapid progress to leeward would be made when sailing 150° or 13 1/3 points from the wind, when the advance to leeward would be 1½ times that of the wind, and the apparent velocity of the wind would be equal to its true velocity.

CHAPTER X

The Scooter and How to Build It

From Data Gathered by J. W. Muller and Henry V. Watkins.

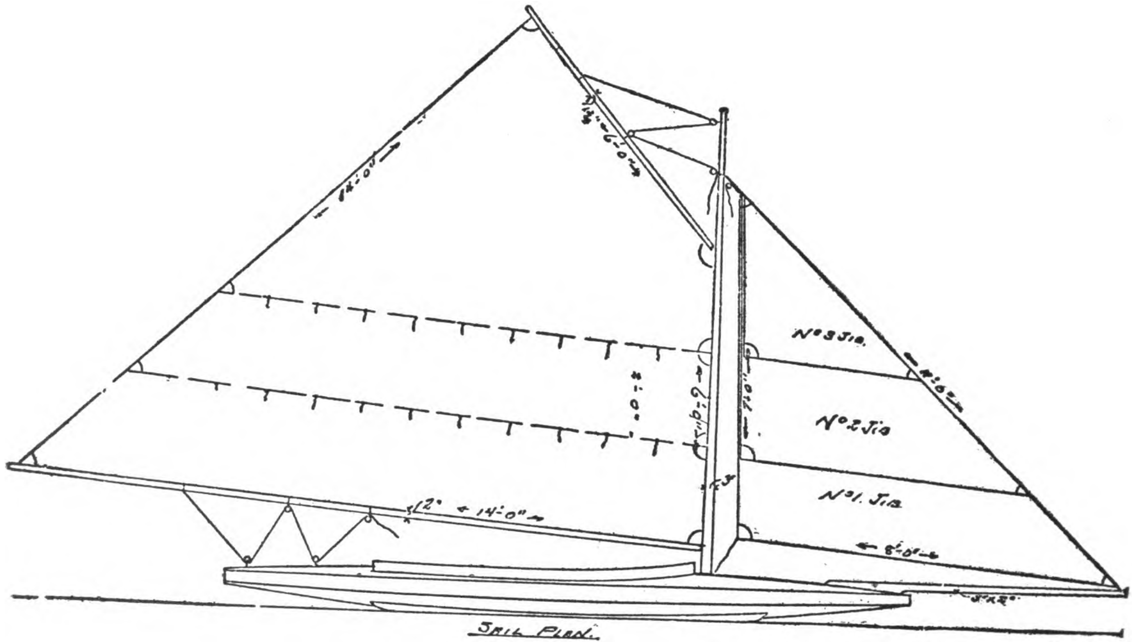
THE scooter, without attempting a literal definition of its name, is a sort of amphibious ice-yacht which first came into use among the baymen and life savers of Great South Bay and other land-locked bodies of water lying on the south side of Long Island, where it was necessary to have some means of communication between the mainland and the outlying beaches, over a broad stretch of bay that was partly frozen over and partly covered with open water and air holes.

These bays present conditions in winter which are peculiar to themselves, owing to the strong tides, heavy winds, and their proximity to the

large body of fairly warm water outside which prevents them from freezing entirely across. Formerly, the only mode of getting from the mainland to the beach was to drag a flat-bottomed boat over the ice and rowing or poling it across the open stretches of water. To lessen the work of dragging the boats over the ice, the life savers and fishermen finally hit on the idea of setting a small sail on the boat to help them along when the wind was fair. Eventually sledge runners were fastened directly on the bottom of the boat, the sail area was increased, and from this crude craft the present scooter was evolved.

In form, the present boat is very much like a ducking skiff, being practically flat on the bottom, though with considerable crown to both bottom and deck, about a foot deep, and steered by sails, there being no rudder. It can travel over the surface of hard or soft ice, can sail through open water when it comes to it, and can lift out on the ice again on the other side with no other assistance than the power of the wind in its sails.

Although the scooter has been used for many years by the baymen, it was only about ten years ago that it began to be used for pleasure



Sail plan of 14-foot scooter.

purposes. Since then, the growth of the sport has been very rapid and there are countless numbers of these craft scattered along the shores of Great South Bay and adjacent waters. Until recently the use of this type of boat was confined to these waters, but a few years ago ice-boat enthusiasts took up the scooter in different parts of the country, and when the pleasure to be derived from them was appreciated the craft grew in popularity, especially where the climatic conditions were such as to make ice strong enough for ice-boating a doubtful thing for any length of time.

The scooter is simple to build and anyone can put it together who can handle tools at all. Most of the ones in use on the Bay are home-built, by men who are not boat builders or carpenters. To-day the typical scooter is from fourteen to fifteen feet long, with a beam of four to five feet. It is well decked all around, particularly forward, so that the open space forms a cockpit only five or five and a-half feet long and two feet to two and a-half wide. Around the cockpit runs a powerful coaming, built to withstand rough knocks, and rising at least three inches above the deck. The entire deck has a gentle turtle-back curve, or crown,

fore and aft and across. This curve of the deck is almost duplicated by the bottom of the scooter, thus making a very slight modification of a flat bottom.

Now come the runners—really the only thing that makes the scooter different from any other boat. They are made of brass or steel. Each has its votaries. The men with brass runners can file them true and sharp whenever they wish, especially before a race, without wasting more than a few minutes. There are conditions where steel runners hold the ice better and again at times the softer brass runners are a decided advantage. On a fourteen-foot boat the runners will be about ten feet long, slightly rocker-shaped, one inch wide and from one and a-half to one and three-quarter inches high, being so set and ground as to bevel inwards. They are set about twenty inches apart. It is in the shape, set, and location of the runners that further evolution and perfection of the scooter as a racing machine probably will come.

The rig is invariably jib and mainsail and in sailing on hard ice or water these sails control the course of the boat. The sail area is from 75 to 125 square feet. The mast which is set

well aft, is from nine to ten feet long. The sails may be rigged in any way customary for small boats. The handiest are the regulation boom and gaff and sprit rigs for mainsails, while it is well to have a small boom for the foot of the jib, because its proper manipulation and set are so important for the handling of the boat. The bowsprit is large and heavy, and projects from two and one-half to three feet beyond the hull. In racing boats it is made removable, so that larger or smaller sticks can be substituted according to weather.

The sail spread of the scooter differs from that of common craft in that the canvas has its greatest extent laterally instead of in height. The scooter wants as much sail as possible astern and in the bow, because it is the canvas alone that steers her. Therefore, a scooter with a nine foot mast may carry a seven or eight foot gaff and a boom extending fifteen feet and more, although fourteen is the usual length tor a nine and a-half foot mast. The leach of such a sail will be fourteen feet or a little more. The foot of the jib will be at least seven feet and the leach about the same.

Most of the boats are built of pine with oak decks. They must be strong, to withstand

the extremely violent wrenches and bumps due to the rough work in the broken ice. The equipment consists of a pair of oars and a pike pole with sharpened points. The latter is as vital to scootering as an anchor is to a yacht. It offers the only method by which the scooterer can work his way through bad mush ice if the wind is not strong enough to force him over or through it. It is needed, also, to bring the scooter around in extra heavy weather, in case the steering power of the jib should not be sufficient to do it quickly, or the sailor lose control of his craft temporarily, a contingency that is likely to happen with bewildering suddenness in the case of a two hundred pound craft with a forty mile wind projecting it over ice smooth as glass.

It is wonderful how well the jib steers the scooter, however. There being no tiller to demand the care of the sailor, he can handle his jib and mainsail alone and thus make them work in perfect harmony. Let go the jib sheet and haul taut the main, and the little boat will come around as sweetly as any deep-finned yacht minds her helm. She will reach and beat into the eye of the wind, and her runners will not make more leeway than most centerboards.

If she is to come up in the wind in a particular hurry, the steersman steps swiftly toward the bow, so that his weight makes the bearing fall on the keel forward, and the lightened stern comes right around. Thus, by nice adjustment of weight and close manipulation of sails, the scooter can be made to turn in her own length—spin around like a top. Practically, the man who can sail any small boat really well can sail a scooter. There are lots of "wrinkles"; but there is only one radically new thing to learn, and that is a queer one.

The scooter's poorest point of sailing is running free before the wind. Indeed, to be precise, the scooter can't sail at all before the wind. The moment the mainsail blankets the jib in a following wind, the steering power is totally gone.

The only way to sail a scooter before the wind is to beat down it. You've got to tack before a wind with a scooter just as you have to tack into one.

One or two make her crew. She can carry three, but it is better to have less. When she darts over smooth ice, the men perch on the coaming, aft to windward, as they do on catboats. When she nears rubble or hummocks,

or prepares to dive into mush or water, all hands stand up, to relieve her of dead weight. To enter open water, she is driven straight at it. That is the time the hand at the "helm" must know what to do with that jib. Should she take it sideways, over she'll go. She must hit it true and be eased as much as may be by cunning play with the mainsail. Once over the first wild careen of her plunge, which is almost identical with the gliding plunge of a "shoot-the-chutes" boat, she skims the water as neatly as she skims the ice. When approaching solid ice again, she must be headed straight into it. Her flaring bow goes up its edge, and if she has arrived with speed, she has slid up on it and is off again on her runners before you know it. If the wind is too light to drive her forcefully enough, she may have to be helped up with pike pole, or with another and unique implement which has been especially desived, which looks as much like a hoe as anything.

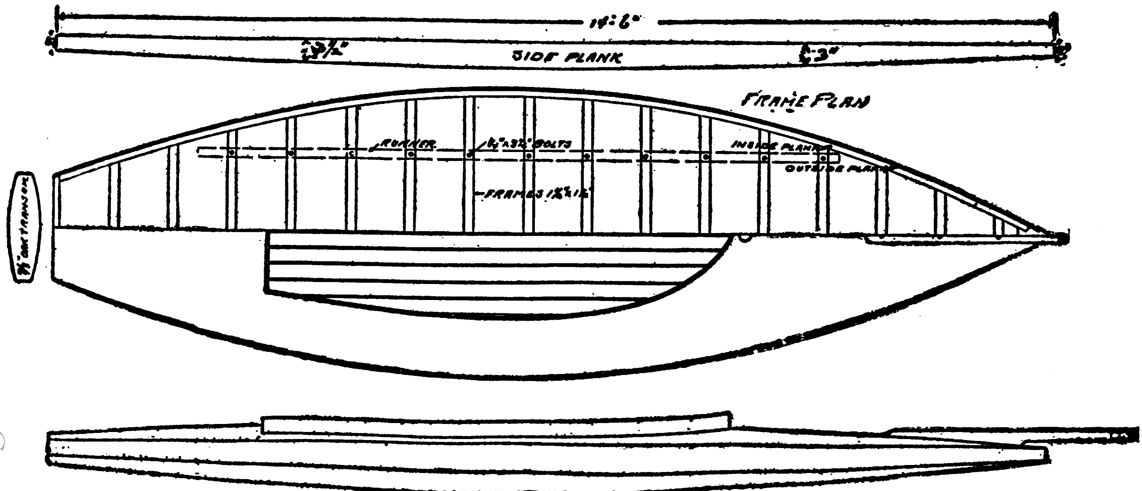
A fair estimate of the scooter's speed is an average of possibly thirty miles an hour under good conditions, though on certain points of sailing, with good ice and a strong wind, she may exceed this for short stretches.

DIMENSIONS AND SPECIFICATIONS FOR BUILDING A SCOOTER

The following specifications and instructions for building are for a scooter 14 feet long, 4 feet wide, and 1 foot deep, from the top of the coaming. This boat was designed for racing and has a bowsprit 3 feet long and carries 91 square feet of sail. The mainsail is shown with two reefs for use in heavy weather. It is desirable in this boat to carry extra jibs—one suitable for each reef, and the size of the jibs is shown on the sail plan. This is essential in order to maintain the proper balance with the mainsail, as the boats are steered by balance of the sails alone.

A fully equipped 14-foot scooter costs from \$100 to \$150, if you have it built. By following the directions here given I think any amateur should be able to get together a very good one at an outlay of less than \$50 for all material, including sails and rigging.

The following is a fairly complete list of all that will be required, except perhaps a few odd size screws and boat nails, paint, varnish, etc.: 125 feet clear ½-inch pine for deck and



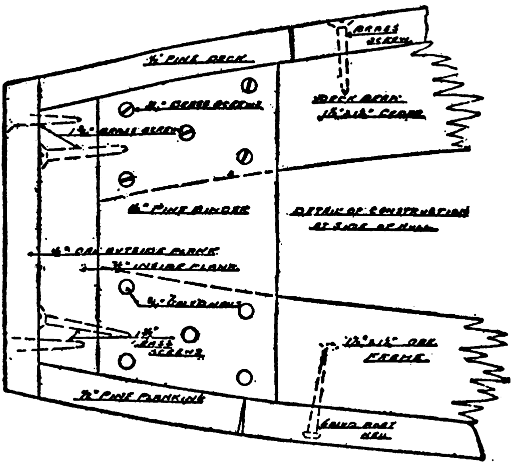
Construction plan of scooter, with measurements of inside side plank.

bottom; 20 feet of 1½-inch oak for bottom ribs, runners, etc.; 10 feet 1½-inch cedar for deck ribs; two strips of ⅞″ by 3½″ by 15-foot clear pine for inner side plank; three strips of ½″ by 4½″ by 15-foot oak for outer side plank and coaming; 5 gross 1-inch No. 8 brass screws for deck, etc.; 1 gross 1½-inch No. 10 brass screws for deck, etc.; 2 pounds 1¼-inch galvanized boat nails for bottom; 2 dozen ¼″ by 3¾″ bolts for runner woods; 1 pair ¼″ by 1″ by 9 feet cold rolled steel shoes and screws for same. Spar of stiff spruce for mast, boom, gaff, bowsprit, jibbooms, and pike pole. The planking referred to above will have to be sawed into lengths of the widths shown on diagrams for frames, planks, etc.

To begin work take the ⅞″ by 3½″ side planks and plane one edge straight. Taper the ends, as shown, to 2 inches. Then get out stem and transom, which should be cut amply wide to receive crown of deck and bottom. Snap a chalk line on a level floor and mark a place for the stem. Seven feet aft of this nail a 14-inch crosspiece, extending, at right angles, two feet out each side.

Now nail the side planks, straight edge down, to stem and bend them around the cross-

piece until the after ends come within 9 inches of the center line. Fit in transom, leaving enough wood underneath to receive crown of deck. (The boat is built up-side down.) Block



Cross section of scooter, showing details of construction and inner and outer side pieces.

the whole frame up from the floor an inch or two to allow for this. Space off the ribs 10 inches from center to center. Get these out of the 1½-inch oak, and mold so as to give crown of about 3½ inches with a flat place 2 feet wide in center.

Put in the fifth and twelfth ribs and then

spring ribbands over them from stem to stern to give the proper fore and aft curve to bottom. Make all the other frames come to these ribbands. Trim side planks to fit bevels shown and proceed with planking with the ½-inch pine, making planks about 4 inches wide, using nails in ribs and screws at the ends, in the side planks.

When the bottom is on, caulked and primed, raise the boat up on benches for convenience in putting on the runner woods and steel shoes.

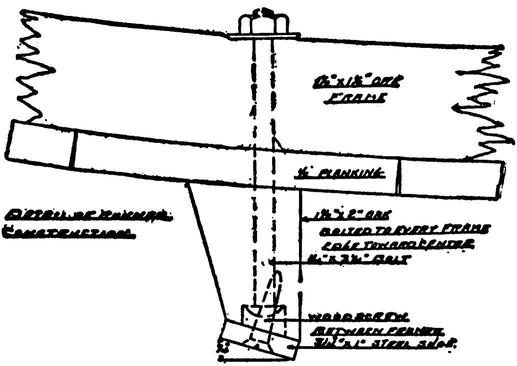
Make straight lines where these are to go, one foot each side of center of the keel, exactly parallel, for 9 feet of the length, stopping at bow end 3 feet from point of stem. Take the 1½-inch oak and scribe it to fit the bottom. Then, 18 inches from each end, rip it off so as to leave a runner about 2 inches high, with a true curve for the 6 feet of ½-inch rise. Give the ends a gentle curve down to the points where they die on the bottom.

Plane off the outside wood from the upper edge till top is 1 inch in width and bevel ¼ inch for steel shoe, as shown in detail drawing. Fasten with ¼ by 3¾-inch bolts, one in each timber. Screw the steel shoes to these wooden runners, first shaping them to fit so that the

screws will have no undue strain in pulling the steel down at the ends.

Now turn the boat over and put in deck frames, giving them a crown sufficient to make the hull 1 foot deep, including coaming.

These frames are made of 1½-inch cedar and the deck is fastened with the 1-inch brass screws. Put binding pieces of light stuff between the bottom and the deck frames at the ends, against inner side plank, and fasten well as per detail drawings.



Detail of runner construction.

The cockpit opening may be of any desired shape, only the mast step must be put in place before decking in case the cockpit is made smaller than shown on the plan.

Trim the edges of deck and bottom planking plumb with side plank, and screw the ½ by 4½-inch oak outer side plank the entire length, trimming off flush with bottom and deck. This binds the whole deck and bottom and protects the edges against cutting in thin ice.

Dress the mast to at least three inches in diameter at the deck. The boom and gaff need be no greater than two inches at the greatest diameter. Make the bowsprit of 2″ by 3″ spruce and fasten so that it points slightly above horizontal line.

Provide the boat with a pike pole with an 8-foot handle similar to a regular ice hook, but with a flattened crosspiece near the hook for use in getting out of thin ice when the wind fails. An oar should always be carried for use in open water.

To sail the scooter trim the mainsail fairly flat. Take the jib sheet in the hand and never lose it, as all the steering on the ice is done by trimming in and slacking off that sail.

You will soon discover its effectiveness and in a few trials you will be surprised by the ease with which the rudderless boat can be managed. It is, in fact, easier to navigate than many

water boats and any person at all familiar with sailing craft can soon become a proficient scooter skipper.

A modification of the scooter is now frequently seen in the so-called motor scooter. This consists of the hull of a scooter fitted with a gasoline engine, in which several methods of transmitting the power are used. In some of these the propulsion is obtained by means of a wheel with a number of short chisel-toothed spikes in its rim which engage the ice, while in others a propeller that works against the air, as in an aeroplane, is used. Each of these methods has proved successful and great speed is claimed for the boats thus equipped, as high as fifty to sixty miles an hour having been obtained, it is said, though reliable data are lacking. In the former methods of propulsion, however, the boats are only good on ice, as the spiked wheel has no appreciable hold in the water. Power scootering has not as yet developed to any extent and hardly occupies a place in the field of ice-boating or scootering.

THE END